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"THE ELECTRICIAN," JULY 9, 1920.

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

VOLUME LXXXIV.

FROM JANUARY 2, 1920, TO JUNE 25, 1920.

171293
16/5/22

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LONDON:
Printed by THE FLEETWAY PRESS, LTD., 1, 2 and 3, Salisbury Court, Fleet Street, E.C. 4, and Published by BENN BROTHERS, LTD.,
at 8, Bouverie Street, London, E.C. 4.

1920.

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THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF
ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE
ESTABLISHED 1861.

No. 2,172. [Vol. LXXXIV. No. 1.] FRIDAY, JANUARY 2, 1920. PRICE SIXPENCE.
By Post, 7d. Abroad, 9d

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Notes.

The Electricity Supply Act.

A WORD at the present moment might not be out of place in regard to the really final amendments in the Electricity (Supply) Bill, which amendments, it may be noted, were meekly accepted by the Commons, so that the Bill finally went forward for Royal Assent but a shadow of its former self. Some will say this was due to the strong opposition of vested interests; but, however this may be, it was certainly due to the fact that too much was attempted. The Bill as it left the Commons tried to give one general solution to a number of complex problems each differing from the other. To use philosophical terms, we think it failed to pass in this form because it tried to treat the abstract as the concrete. It was decided, quite legitimately, that the electricity supply of the country required reorganisation, and if it had given general powers for this reorganisation to be carried out and stopped there, all who have the welfare of electricity supply at heart would have welcomed it as a constructive piece of legislation; but, as is the custom in modern legislation, it tried to say how this reorganisation was to be carried out, and brought a hornet's nest about the ears of its authors. There is, indeed, no entity that we can call the electricity supply of the country. What we have got are numerous electrical problems to solve in certain districts, each varying with the particular district. London, Lancashire, Yorkshire, Northumberland and Durham, the Midlands, and so on—they all have a common complaint, the need of reorganisation; but, as to the form the reorganisation should take, each district demands its own particular treatment. There is, for instance, absolutely nothing in common between the case of Lancashire (as it stands as an electrical district) and London. Or what similarity is there between the Midland and the Northumberland and Durham districts? But the promoters of the Bill tried to find a solution to fit all these cases—and failed, naturally. A tailor might just as well try to cut a suit of clothes to fit half a dozen men. It might be an "average" suit, but it would fit none. This really, at the bottom, accounts for the unpopularity of the Bill in all quarters. Now, however, there seems a likelihood of arriving at the solution of each particular problem individually. Provided that the Act ensures this possibility (with a cudgel in the background for the recalcitrant) there is every hope of reorganisations (in the plural) taking place. And we hope the Commissioners will lose no time in getting to work.

An Increase in Effectiveness.

As to the increased effectiveness of the Act as it is now amended there can be no doubt. A great many of the restrictions under which companies have laboured in the past are removed, and the Commissioners have the power to facilitate the reorganisation of electricity supply in many ways, of which we hope they will take full advantage. There is, for instance, nothing now to prevent undertakings in a district, both company and municipal, from joining together and going ahead in a joint scheme for the general good. The one thing to be deprecated will be any continuation of the internal jealousies which in the past have prevented anything like real co-operation. But the experience of the privately owned undertakings, in narrowly escaping what they certainly thought to be bad times, ought to have considerable influence in bringing them to a proper state of mind to co-operate. Those who are responsible for the various schemes which are at present more or less in hand—such as those in Manchester, Newcastle, Yorkshire and Nottingham—can now go forward with a little more confidence. As to London, the more settled condition augurs favourably for solution of the problem, and the official recognition given to private enterprise in the Bill should be taken to heart by those municipalities who have proposed a scheme in which the only part the companies were to play was to quietly "die out." At the same time the companies ought also cease from obstructing.

The Electricity Commissioners.

THE personnel of the Commissioners is second only in interest to the Electricity Act itself. Who are to be the Commissioners is now the question of the moment? The last-minute alterations in the Act has made things depend even more than formerly on the personal equation. The interest felt in this is evinced by the question asked recently in the House of Commons by Sir FREDERICK HALL. The occasion was the reference in our columns to the selection of Mr. W. B. WOODHOUSE. Sir FREDERICK HALL wanted the Ministry of Transport to corroborate this and to give a complete list of the proposed Commissioners. Mr. NEAL, answering for the Ministry, suavely temporised—he did not know, neither would he tell, the names if he did know, neither did he think it proper to do so, when the Bill had not reached the Statute Book So speculation can still indulge its curiosity There is one thing that narrows down the possibilities. They must all be British subjects. They must have sympathy, broad outlook, tact. They must all be, in a word, good men and true. There is a minute specification in the Act as to the engineering qualifications they must possess, all of which certainly ought to make the "short list" very short indeed. The industry does not, as a matter of fact, contain a plethora of candidates still, it ought certainly to yield up five to specification. The Board of Trade have a very important function to perform in this selection, since if there ever was an occasion when the most judicial discrimination was necessary it is in the present case. It is of immense moment to the whole electrical industry that a wise choice should be made.

The Moulders' Strike.

On September 20, 1919, the moulders of this country went on strike, and in spite of more than one conference and of the efforts of peacemakers representing both Capital and Labour, they still remain on strike. The effect of such a prolonged cessation of output of castings is as obvious as it is regrettable to all who know anything about the conditions under which the engineering trade is carried on. And it would not be too much to say that as a result of this disagreement the engineering industry and the production of essential goods are being slowly strangled. Now the inability of the general public to realise how directly this strike affects them is, we think, one of the reasons for its long continuance. In the case of the recent railway strike the blow to the general comfort and welfare was immediate. No one was unaffected, and it was therefore certain that whatever happened the strike could not last for very long, and that sooner rather than later an arrangement would have to be come to. In the case of the moulders' strike the harm done works more insidiously with the result that even our daily contemporaries are only just beginning to realise the full effect of this disastrous misunderstanding, and are now demanding that every effort should be made to bring about an agreement. It is certainly time this was done, for if it is not all our hopes for the reconstruction and development of the engineering industry during the forthcoming year are likely to be irretrievably shattered.

Small Cause and Great Trouble.

The strike in itself is unfortunate enough, but it is made the more unfortunate by the pettiness of its cause. It will be remembered that the three trade unions representing the employees in the moulders' trade in the late summer of last year objected to an award of the Court of Arbitration on a wages claim. The effect of this award was that no change would be made in the then existing terms of the agreement until the time the next hearing was due, which was last October. This award applied not only to the moulders' unions but to some 51 unions connected with the engineering trades. All these loyally accepted the award except the three moulders' unions, who demanded immediate concessions; these being refused they came out on strike. Shortly after the strike began the parties came together and agreement seemed probable, but when the matter was put to the ballot of members an overwhelming majority decided to continue on strike; and the provisional terms of the settlement which had been arranged were thrown over. Even then the matter at issue was small, centring round whether the workers should or should not be granted an increase of 15s. per week. So the strike continued, and nothing more was done in the way of persuading the parties to agree until shortly before Christmas, when a further conference took place. From statements which have been made by Sir Allan Smith, for the employers, and by Mr. Arthur Henderson, for the workpeople, it was evident that at this meeting a settlement had practically been arrived at, the men at any rate being in a less stubborn frame of mind than they were at first. The latest news is, however, that settlement is once more delayed because the employers stipulate that certain moulders in West Bromwich who ceased work before the national strike began should return to work with the rest of the men. Now, the West Bromwich case is on a different footing from the rest of matters under dispute. It relates to three men who worked in a foundry but who belonged to the General Workers' Union and not to one of the moulders' unions. Pressure was brought to bear on these men to leave their own union and to join one of the unions more closely connected with the foundry trade. When they refused to do so the men working with them struck. It will therefore be seen that this matter is an internecine dispute, and has primarily nothing to do with the employers. It is, therefore, a great pity that it has been dragged into the more important discussion of the reasons which led to the general stoppage. In considering this strike general sympathy was first of all with the employers, but by exhibiting an entire lack of tact in the negotiations, and by seizing on what is quite an external matter to act as a lever to force fresh concessions from the employees they have succeeded in bringing public opinion round to the other side. This is not surprising. For the masters in insisting upon the West Bromwich question being settled along with the other have made a grave mistake. In fact, it may be said, the whole history of the dispute is simply a series of mistakes, and meanwhile everyone is feeling the results. Works have been brought to a standstill, production is being reduced to nothing, workers in other trades are suffering through lack of employment, and the trade union funds are gradually being depleted. The latest news is that the Prime Minister has been asked to intervene. We hope that he will do so and that some settlement will be speedily arrived at. It is not a time for either side to stand on its dignity, but it is certainly time for everyone to get back to work.

Expiring Patents.

Among the patents which will expire this year, unless their normal life is prolonged, are a number of considerable interest. For example, there are two patents (Nos. 3,213 and 18,622 of 1906) relating to the manufacture of metal filaments, at least one of which was cited in recent litigation on this subject. The former was granted to Just and Hannaman, and describes the manufacture of sintered filaments, the carbon from the binding material being removed by heating in steam and hydrogen. The latter, granted to the Deutsche Gasgluhlicht A. G. (Auergesellschaft) calls attention to the danger of an excess of oxygen, and therefore the inventor effects the decarbonisation in an atmosphere containing nitrogen and hydrogen, or ammonia, but no oxygen, the carbon being apparently removed in the form of cyanogen. Patent No. 13,903, to Stevens, of Tilling-Stevens fame, describes the use of a special dynamo for petrol-electric vehicles. The dynamo has two distinct windings, with separate commutators, each of which supplies half the field winding and half the battery or load direct if desired. By means of a special switch these windings are coupled in series or in parallel as required. Quite a number of the patents are electro-chemical. Thus there are two Edison patents (Nos. 1,924 and 1,928) which describe the special procedure adopted in order to secure sufficient conductivity in the plates of the Edison cell. Patent No. 1,716 describes the Finlay electrolytic cell, used for electrolytic alkali. In this cell the two electrodes are separated from each other by diaphragms and by a central chamber which receives the fresh electrolyte. A good many years ago some quite promising tests in regard to this cell were published in the "Transactions" of the Faraday Society, but we do not remember hearing of any further progress in this direction. No. 4,336, to Bingham, protects the use of an auxiliary electrode for fusing the block of material in the tapping hole of a carbide furnace, thus rendering the tapping a more simple operation. A patent to H. Pauling (No. 18,599) claims an improved method of supplying the air to his well-known furnace. The air is introduced by two sets of tubes which blow into the arc space from opposite directions, so as to form, as it were, a disc of air with the electrodes in the plane of the disc and near the centre. Returning to more purely electrical matters, we notice a patent (No. 1,947) to J. S. Highfield for a method of obtaining suitable earths for return circuits of high pressure continuous-current transmission. It will be remembered that Mr. Highfield published some interesting figures on this question in a Paper read before the Institution of Electrical Engineers at Paris in 1913. Patent No. 6,454 covers the well-known Lea recorder, which is now so popular in power stations. Among the many wireless patents may be mentioned one to Marconi (No. 3,127), covering the use of horizontal radial antennæ connected to a switch so that any one of the radial arms can be brought into circuit. The maximum effect is, of course, obtained in the arm which is pointing away from the radiating source. No. 27,725 describes the Brockie magazine arc lamp. Considerable interest now attaches to patent No. 26,941 to Meirowsky owing to the increasing use of tubes made of "built-up" paper insulation. The patent describes the manufacture of tubes from insulating material, hot rollers being used for the purpose. It is interesting to notice how the number of patents dealing with subjects of electrical and engineering interest is steadily increasing year by year, and especially how an increasing number of patentees find it worth while to pay the fees to keep their patents alive. This may be taken as a sign of progress.

Award to the "Electrician"

Our readers will be interested to know that we have received a communication from the Board of Trade informing us that we have been awarded the Diploma of the Grand Prix *en collective*, by the International Jury of the British Section of the Ghent International Exhibition, 1913. The issue of this award has been deferred until now in consequence of the war. Indeed, it seems a far off day enough since the time when International Exhibitions were, so to speak, all the rage, and when the unity of nations was said to be improved by their organisation. But even if they did not succeed in maintaining international peace, these exhibitions had distinct uses, though this was not perhaps realised to its full extent in this country. Now while any international exhibition must to a large extent cater for the inhabitants of the country in which it is held, and while every exhibitor must bear this point in mind in planning his exhibit, its greatest use is to bring the name of the particular firm, and better still, of the particular country in which that firm operates to the general notice. Direct orders may or may not result, but in any event great good will be done. It is to be expected that in the future these international exhibitions will again be organised, and we hope that representative and collective exhibits from British firms will be conspicuous. This matter is one which might well be considered by those engaged in the work of reconstruction, as it is a form of propaganda which could be made of the greatest possible use.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

In an article on "Criteria for Testing Magneto Magnets" (page 4), Mr. J. D. Morgan points out that the practice relating to the testing of magnets for magnetos is not altogether on a satisfactory basis.

In an article entitled "What the Adoption of Higher Steam Pressures Will Mean" (page 7), Mr. F. R. Parsons shows how the adoption of higher steam pressures in engineering practice will modify the design and construction of boilers.

On page 8 we continue our account of Messrs. D. M. W. Hutchison and W. J. Wayte's Paper on "Electricity in Tin Mining," read recently before the Institution of Electrical Engineers.

An article on page 10 deals with the developments in the design of Messrs. Brown, Boveri's mercury arc rectifiers.

On page 14 we give an account of a presidential address delivered to the Junior Institution of Engineers by Sir E. H. Tennyson D'Eyncourt on "The Influence of War on Engineering."

Our usual serial article entitled "Heating and Cooking Notes" deals this week with the general progress that has been made in this direction during 1919 (page 14).

On page 15 we give an account of the discussions which took place at Glasgow and Birmingham on Capt. J. M. Scott-Maxwell's Paper on "Scientific Management," read recently before the Institution of Electrical Engineers.

We publish on page 16 the numbers and titles of patents of electrical interest expiring during 1920.

Our Leading Article (page 19) deals with matters of interest to electrical engineers which occurred during 1919.

A report by Messrs. Meik & Buchanan and Sir Alex. Binnie, Son & Deacon to the Dundee Corporation on the proposed Tummel water-power scheme is given in abstract on p. 21.

The Report of the Board of Trade Committee on the Gattie Transport Scheme is given on page 22.

Arrangements for the Week.

ROYAL INSTITUTION.

At Albemarle-street, Piccadilly, London, W. Christmas Lectures for Juveniles on "The World of Sound," by Prof. W. H. Bragg, C.B.E., F.R.S.

Saturday, Jan. 3rd.
3 p.m. Lecture III. "Sounds of the Country."

Tuesday, Jan. 6th.
3 p.m. Lecture IV. "Sounds of the Town."

Thursday, Jan. 8th.
3 p.m. Lecture V.—"Sounds of the Sea."

FRIDAY, Jan. 2nd.

Junior Institution of Engineers.
7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Automatic Electric Weighing Machines, as Used with Machine Packers," by Mr. A. V. Sims.

TUESDAY, Jan. 6th.

Rontgen Society.
7 p.m. At the Royal Photographic Society's House, 35, Russell-square, London, W.C. 1. Lecture on "The X-rays approached from the Popular Standpoint," by Dr. G. H. Rodman, F.R.S.

Engineers' Club.
7 p.m. At Albert-square, Manchester. Address on "The Textile Industries of the United States," by Mr. F. Nasmith.

Institution of Electrical Engineers, N.W. Students' Centre.
7.30 p.m. At Houldsworth Hall, Deansgate, Manchester.

WEDNESDAY, Jan. 7th.

Royal Society of Arts.
3 p.m. At John-street, Adelphi, London, W. 6. Juvenile Lecture on "Railways and Engines," by Mr. L. Pendred. (Lecture I.)

Physical Society.
3–6 p.m. and *7–10 p.m.* Exhibition at Imperial College of Science.

Liverpool Engineering Society.
8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Adjourned discussion on "The Science and Art of Lubrication," by Mr. H. T. Newbigin.

THURSDAY, Jan. 8th.

Physical Society.
3–6 p.m. and *7–10 p.m.* Exhibition at Imperial College of Science

Institution of Electrical Engineers.
6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Failures of Turbo-generators and Suggestions for Improvements," by Mr. J. Shepherd.

Criteria for the Testing of Magneto Magnets.

BY J. D. MORGAN, M.I.E.E.

Engineering tests can be resolved into two main classes—(*a*) Tests on materials, and (*b*) tests on products. Material tests provide data for designers, and product tests data for users. The designer of a steel girder, for example, requires to know the properties of the metal to be employed in the girder, and material tests are made to give him the required information. The user of the girder is not primarily concerned in knowing the quality of the metal. His principal need is to know whether the girder will support a given load. He, therefore, applies tests which are directly related to his requirements; in a material test the material only is involved, but in a product test there are involved conditions due to the design and the manufacture as well as those due to the material. In some cases a material test only is used, and this is made to serve the purpose of both the designer or maker and the user of the article into which the material is converted. Such a test is only indirectly valuable to the user, although if rightly interpreted it may suffice. It is important to recognise, however, that where the properties of a given product depend upon factors other than those of the material, a material test does not directly meet the needs of the user. Experience proves that it is important to keep the foregoing clearly in mind when approaching the subject of tests for the permanent magnets employed in ignition magnetos.

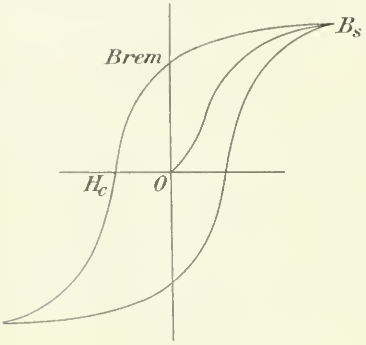

FIG. 1

The general practice at the present time in this country in testing magneto magnets is to obtain by means of a material test the remanent magnetism (Brem) after saturation and the coercive force (H_c), although certain supplementary (material) tests are now becoming common. It cannot be said that the practice relating to magneto magnet testing is on an altogether satisfactory basis, and the object in the following is to indicate briefly certain rudimentary facts from the consideration of which appropriate tests might be evolved.

B.H. Curves.—The most familiar method of correlating magnetic flux, and the magnetising force required to produce that flux, is by means of a B.H. curve. A typical complete curve is shown in Fig. 1. It is understood that in obtaining the curve the magnet is taken up to the saturation point. Starting from zero and rising to saturation the curve follows the line OB_s. On removing the magnetising force the flux falls to Brem, which indicates the residual magnetism in the specimen, so long as the latter is subject to no demagnetising action. On applying a reverse, or demagnetising force, the flux falls until it reaches H_c, which represents the coercive force of the specimen. The curve B_s Brem H_c forms part of a hysteresis loop. As is well known, the magnetic condition can be caused to pass through a complete cycle, the curve of which continues from the point H_c, and terminates at the starting point B_s. It is only necessary to consider the lines OB_s and B_s Brem H_s.

In some cases it is possible to express by an equation the relationship between magnetic flux or induction (B) and magnetising force (H). For a simple magnetic material (*e.g.*, pure iron) the magnetisation follows very closely what is known as Frohlich's law, which, in words quoted by Steinmetz, can be expressed thus: Permeability is proportional to magnetisability. Expressed symbolically:

$$\mu = a\,(S-B). \qquad (1)$$

where
μ = permeability.
a = constant.
S = saturation density.
B = flux density.

By substituting $\mu = B/H$ in (1) and re-arranging it follows that

$$B = \frac{H}{\alpha+\beta H}, \qquad (2)$$

where α = initial value of μ, and $\beta = 1/S$.

Kennelly's variation of the above is obtained by substituting ρ (reluctance) for $1/\mu$ or H/B in (2), whence—

$$\rho = \alpha+\beta H. \qquad (3)$$

In a discussion of equations (2) and (3) Steinmetz states that B does not reach a saturation value, but increases indefinitely with H. He observes, however, that there is a value of B denoted by B_i, which does tend to a saturation value, and this value he obtains from the relation—

$$B_i = B - H. \qquad (4)$$

Frohlich's and Kennelly's laws, therefore, apply to B_i, and not to B. Steinmetz adds that B_i may be considered as the magnetic flux carried by the molecules of the magnetic material and H the space flux, or flux carried independently of the material.

The magnetisation curve of a material following Kennelly's law is as indicated by (*a*), Fig. 2, which shows the relation between B and H. The relation between ρ and H is shown by (*b*).

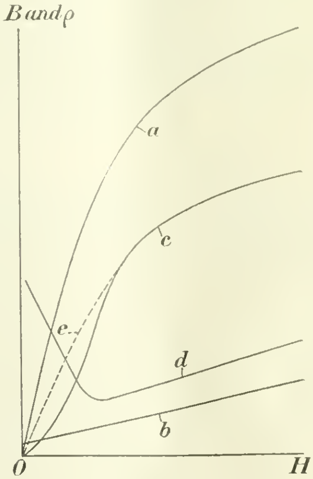

FIG. 2

Complex materials such as those used in permanent magnets give a magnetisation curve like (*c*), having an inward bend near the origin, and the corresponding $\rho - H$ line is not straight at the origin, but takes the form shown by (*d*). Even the apparently straight portion of (*d*) is not actually straight, but is a flat curve whose inclination to the axis of H increases slightly with increasing H. The inward bend shown in (*c*) is, according to Steinmetz, a part of an unsymmetrical hysteresis loop, and its form depends on the condition of the material prior to magnetisation. The earlier part of the curve (*c*) represents an unstable magnetic condition, and one which varies with the manner in which the magnetisation is effected. Ewing mentions that when the magnetisation curve is obtained while the specimen is being subjected to a longitudinal alternating current, the initial part of the curve takes the form shown by dotted lines (*e*), Fig. 2. Steinmetz regards this as representing a stable magnetic condition, and states that it follows Frohlich's or Kennelly's law, subject to the modification expressed by equation (4). Mr. E. A. Watson has found that equation (3) can be adapted to fit very closely the line Brem H_c given by a permanent magnet which has been saturated. Mr. Watson's modification of Kennelly's equation is—

$$\frac{H+H_c}{B}=\alpha+\beta(H+H_c). \quad . \quad . \quad . \quad . \quad . \qquad (5)$$

Plotting $(H+H_c)/B$ against H the equation represents a straight line.

Material Tests.—The foregoing indicates briefly the relationships of the principal quantities which may be used in material tests on magnet steels. Clearly measurements on the line OB_s, Fig. 1, are of no value, owing to its variability for the same specimen. As the point B_s is not easily determined this also is ruled out of consideration. The common practice at present is to measure the points Brem and H_c on the hysteresis loop, these points being capable of easy and precise observation. On reflection it will be apparent that the said measurements are not, however, sufficient to distinguish between steels of different qualities giving the same values of Brem and H_c. Fig. 3 shows two hypothetical curves lying between the same limiting values. For magneto purposes the curve *a* indicates a better magnet steel than *b* for the reason that it will give a greater flux in a circuit of given reluctance than that corresponding to *b*. Some magnet users have, therefore, adopted the practice of measuring a third point on the curve—namely, the value of B corresponding to some selected intermediate value of H. The writer has suggested, as the third figure, the maximum product of B and H between the limits H_0 and H_c, this product being designated $BH^{\max}$. In Fig. 3 the curves *c* and *d* show how the product of B and H varies with H in the curves *a* and *b* respectively. The product $BH_{\max.}$ is one which can be very easily determined in the course of the test for Brem and H_c. (*See* "Engineering," April 25, 1919.)

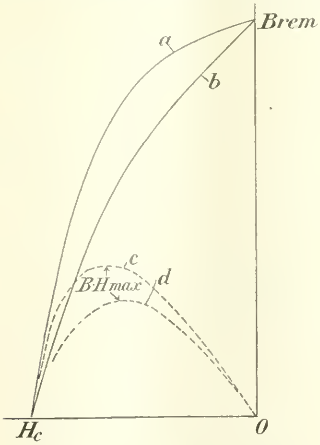

FIG. 3

Seeing that the three points above mentioned on the left-hand segment of the hysteresis loop give satisfactory data for comparison of the magnetic properties of steels and that such points can readily be determined, it is doubtful whether any practical advantage is to be gained by adopting for comparative purposes the numerical values of the constants in equations (3) and (5). Both the product and the ratio of Brem and H_c have been proposed and used as indexes of magnetic quality, but there is no general agreement that these quantities have any practical value. The BH curve itself appears to be the best index of the quality of a magnetic material, and in the writer's opinion any test figures adopted in lieu of the curve should be such that they suggest or indicate the main characteristics of that curve.

Magnet Test.—The common practice in this country at present is to test a finished magnet by measurements of the magnetic qualities of the material from which the magnet is made; in other words, it is usual to measure Brem and H_c, with or without an intermediate measurement. There is hardly any need to argue that these measurements do not give a direct index of the practical usefulness of a magnet. It must be admitted that they serve in the absence of a simpler and more direct test for the comparison of magnets with a geometrically similar standard which is known to satisfy practical requirements, but they do not enable a direct comparison to be made of the practical usefulness of magnets which are geometrically dissimilar. A simple product test (or direct test of a magnet as a source of flux) is needed. That such a test is practicable will be seen from the following. The test described hereunder consists in measuring the flux produced by a magnet after it has been subjected to the self-demagnetising force which is set up when a magnet is removed from a magnetising apparatus without a keeper on its limbs.

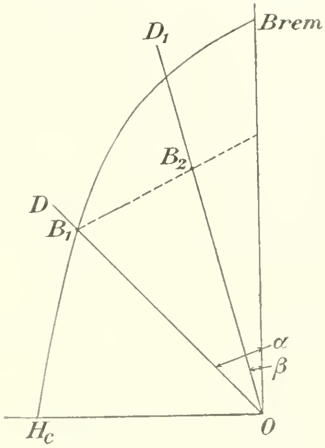

FIG. 4.

Let the curve Fig. 4 represent a portion of a B.H. curve obtained after saturation of a magnet. Draw the lines OD, OD', such that the angles α, β represent respectively the maximum and minimum demagnetising forces to which the magnet is subjected in service. B_1 on the line OD is proportional to the flux which the magnet will produce when subjected to the maximum demagnetising force. The flux which the magnet will provide when the demagnetising force is reduced to the said minimum will be proportional to the value represented by the point B_2, which lies very nearly on the dotted line axis of a subsidiary hysteresis loop. When, as occurs in a magneto, the demagnetising force, whether due to reluctance or armature reaction, fluctuates repeatedly between the limits shown, the flux values will fluctuate between the limits which are proportional to B_1B_2. It is found in rotary wound armature magnetos using horseshoe magnets that the maximum demagnetising force due to armature reaction (obtained when the armature is rotated with the primary short-circuited throughout each complete rotation) is very nearly as great as that due to the self-demagnetising action set up when the magnet is on what is termed "open-circuit"—that is, when an air-gap only occupies the region between the limbs of the magnet. Measurement of the flux on open circuit serves, therefore, as a perfectly satisfactory magnet test. In proof of this statement, two cases will be considered. Fig. 5 shows portions of BH curves for two magnets having identical values of Brem and H_c. The ordinuary measurements of Brem and H_c would not discriminate between the magnets. A measurement of BH (max.) or some intermediate value of B corresponding to a specified demagnetising H would, however, enable the better magnet to be found provided the magnets were geometrically similar. If after magnetisation each magnet is taken off the magnetising apparatus with its limbs unprotected each will be exposed to a demagnetising force indicated by the line OD. A single measurement of the flux in each case will then give a value

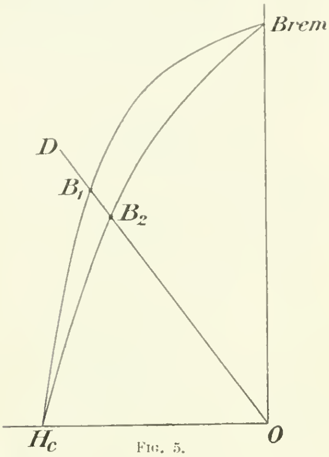

Fig. 5.

proportional to B_1 in the one case, and B_2 in the other, and for all practical purposes the test is as complete as the ordinary material test involving three measurements.

The flux given by a magnet under working conditions depends not only on the material, but also on the shape and size of the magnet. What the user is interested in, *ceteris paribus*, is flux. Material tests give him no direct information on this point, but a magnet test as above described provides him at once with the information he requires.

The second case of geometrically similar magnets made from dissimilar steels will be considered with reference to Fig. 6. Here are shown portions of two BH curves having different Brem and H_c values. The ordinary measurements of Brem and H_c, whether combined with BH_{max} or some equivalent quantity or not, will give the user no direct information as to the suitability of the steels for a particular service. Again, draw the line OD to represent maximum demagnetising force. This line cuts one curve in B_1 and the other in B_2. The latter is the higher flux value, and a single measurement of open circuit flux enables the user at once to know which of the magnets will give the greater flux. Obviously if the line OD cuts the intercept of the curves the open circuit test fails to distinguish between the magnets. This is only likely to occur in practice when the B.H. curves approximate very closely to each other, and then the magnets compared will be for all practical purposes equivalent.

For carrying out the above magnet test a search coil and Grassot fluxmeter is a convenient apparatus. Some magnet users are, however, already equipped with material testing instruments consisting of a moving index coil supplied with a constant current and mounted between pole-pieces to which the magnet is applied. These instruments are equally useful for carrying out the magnet test provided the magnet after magnetisation is first subjected to demagnetisation by removal from the magnetising apparatus without a keeper. The flux values indicated will, however, be higher than those given in an open circuit test, and will lie somewhere on the dotted line, Fig. 4. To enable different instruments to give the same results with the same or similar magnets the instruments would need to be standardised.

Permanence.—It will be observed that nothing is said in the foregoing about permanence. On this subject there is a good deal of uncertainty and some misunderstanding. It is believed by many that coercivity is an index of permanence. In a very general way it is probably true that permanence increases with coercivity provided that widely different coercivities are considered. In permanent magnets, however, which necessarily have high coercivities, not widely different, measurements of the latter do not necessarily give any information as to relative permanence. At the present time the writer has under observation two magnets having the same coercive force. Both are undergoing a natural ageing process. Periodic measurements show that one has deteriorated very much more than the other.

The usefulness of the measurement H_c in a material test is that when correlated with Brem and taken in conjunction with previous experience it gives some relative idea of the flux which will be produced by the magnet in a path of given reluctance, but it does not give any idea of how that flux will be maintained with the lapse of time or under different demagnetising influences. The following argument is sometimes put forward. Of two magnets one is found to have a larger Brem and a lower H_c than the other. When put into service on a magneto the magnet having the larger H_c gives the greater flux. This is said to be because the latter magnet is better able to resist demagnetising effects, and is therefore more permanent. Consequently it is desirable to have as high H_c as possible, even at the cost of Brem. The argument, though apparently a clear interpretation of experience, really arises out of confusion. It will be evident from Fig. 6 that the performance of two such magnets can be predetermined. Assuming that the B.H. curves are as shown, draw a line OD to represent the maximum demagnetising force to which the magnets will be subjected. The magnet having the larger H_c will give the greater flux, the relative fluxes being as indicated by the points B_1B_2 Supposing the maximum demagnetising force is such as is represented by the line OD', the magnet having the higher Brem will give the larger flux, the relative fluxes being then indicated by B_3B_4. The point which it is desired to make is

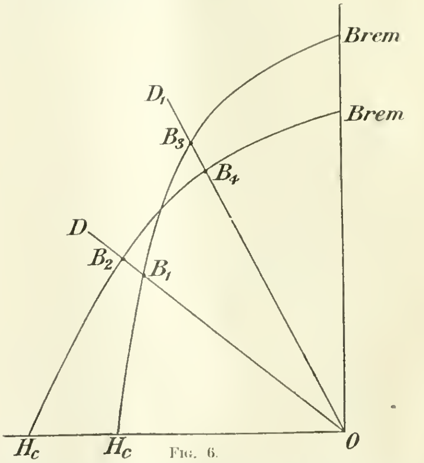

Fig. 6.

that no information is gained from the measurement of H_c as to how the said flux values will be maintained in service, and there is no justification for asserting that the magnet having the higher H_c will necessarily be less liable to deterioration than the other.

The question of a satisfactory test for the permanence of magneto magnets is one which requires investigation, though experience with magnets in service does not suggest that any great practical advantage would result from the use of such a test, as the magnets which pass the usual material tests appear to be sufficiently stable for the requirements of magneto practice.

What the Adoption of Higher Steam Pressures Will Mean.

By F. R. Parsons.

In theory it has long been established that there is everything to gain by the adoption of relatively high steam pressures, and practically nothing to lose. As long ago as 1896 Prof. R. H. Thurston made this abundantly clear in his paper on the "Promise and Potency of High-Pressure Steam." And since that time the science of thermo-dynamics having been more widely recognised by engineers as a sure guide to improvement of heat engine economy, the tendency to increase the temperature range of the working fluid has been more than ordinarily active.

But of these figures we have at the moment little concern; they merely lead the way to more practical considerations. They take us quite naturally up to that point where we begin to consider the ultimate possibilities involved in the adoption of much higher steam pressures. And here must we divide into two separate and distinct phases of treatment our lines of thought: for we shall have to consider (*a*) what the adoption of higher steam pressures would mean in the design and construction of boiler machinery, and (*b*) what it will mean in the design of those parts outside the boiler, and which are to be subjected to the proposed higher pressures and higher temperatures.

An Example of Present-Day Practice.—In the best present day practice, except for slightly higher pressures in some few isolated cases, the maximum steam pressure is 200 lb. per sq. in. absolute, the super-heat 200° Fahr. The corresponding temperature of evaporation is therefore 382° Fahr., the bulk of the heat being absorbed at a temperature 200° Fahr. below the maximum. An outside instance of the practical adoption of a considerably higher steam pressure than this is supplied by the 1,500 kw. turbine installation recently constructed by the British Thomson-Houston Co., in which a steam pressure of 350 lb. per sq. in. was employed, together with a superheat of 700° Fahr., exhausting into a condenser of 28½ in. vacuum. As clearly illustrating the measure of economy obtained as a result of such increase of pressure and superheat, it was claimed that during a 10-hour full load test only 1·83 lb. of coal per unit generated was consumed.

This, perhaps, might well be considered a notable achievement in a twofold sense, inasmuch as such increase of pressure was accompanied with an almost unprecedented increase in temperature of the working fluid. Certainly it stood as an exemplification of far higher temperatures than had hitherto been employed outside experimental phases. But we will deal with this aspect of the case at a later stage.

Effect on Standard Boiler Design.—Assuming the employment of higher steam pressures to be justified what effect will this have upon standard boiler design? Present-day boiler designs and specifications do not permit the generation of steam at a pressure higher than 200-250 lb. per sq. in. without sacrificing safety, and without calling for an investment in the boiler plant high enough to offset the gain in economy caused by higher steam pressures.

Must all existing examples of boiler design be scrapped? Must all drums and steam vessels of large diameter, flat surfaces and even dished ends be abandoned—yes, even if stayed? Will all riveted, expanded or beaded joints exposed to the action of the fire have to go by the board? Will nothing but electrically welded joints permit such an increase as contemplated? Will the high-pressure generator of the future be cylindrical? Of the water-tube type? Or of the flash type? Is increased efficiency to be effected primarily along lines altogether different from those obtaining in boilers working under pressures used to-day? Or is it possible to retain present day design and to increase the evaporation per sq. ft. of heating surface twice as high as that represented by the present-day practice?

These are questions involving much thought, demanding perhaps new and original channels of investigation, pregnant with possibilities. Who knows? Perhaps, after all, our best brains in the realms of engineering science, our efforts, our striving after heating efficiences have been utterly misdirected, in that they have been conducted along altogether wrong channels. When an apparent limit has been reached in one particular direction often it is that a striking off at a tangent into the seemingly impossible will result in undreamed of achievement.

In view of the considerably higher temperatures involved in the production of these high steam pressures we have in mind, and supposing the waste gases leave the boiler at a temperature of 700°-800° Fahr., will it not be necessary to conserve as large a proportion as possible of the heat units if efficiency is also an end in view? This will bring us to a new consideration of the functions and limitations of the economiser. Or might it be suggested tentatively that the waste gases, or at least a portion of them, might very profitably be used in a regenerative form to heat the air which supports combustion in the furnace?

Effect on Materials.—Passing from the boiler itself to outside constructional parts in the event of higher steam pressures being generally adopted, we find less insuperable difficulties barring the way. Pressures of from 600 to 800 lb. per sq. in. are not uncommonly met with to-day in internal combustion engine practice, as evidenced by the Diesel engine; higher even than these in compressed air and hydraulic installations. But it will not be pressure alone that will have to be taken into account in the matter of future design innovations; an increased superheat will mean infinitely more than any contemplated pressure increase. If we add 600° or 700° of superheat it is quite true that we shall effect a considerable saving, notably in pipe lines, seeing that higher velocities would be used, and that superheated steam has a much lower thermal conductivity than saturated steam. But what of the boiler fittings and valves, the blading at the high pressure end of impulse turbines? In the latter connection the proposed increase of pressure might well be compensated for by increasing the thickness of the walls, by substituting steel for cast iron, but very much higher temperatures will necessitate the adoption of a special heat-resisting steel alloy for the blades at the high-pressure end of the turbines. Or it may well be that much of the difficulty in this direction will be got over by the employment of cross compound types of turbine, such as are employed in marine work, each turbine driving a separate generator, the change of temperature in each unit being thus considerably reduced.

High Pressure and Reciprocating Engines.—With such increase both of temperature and pressure, reciprocating engines of the double flow type must, because of their excessive condensation losses at the period of steam admission, and to heat transference between the steam and the cylinder walls, give place to the uniflow type of piston engine. But as against the adoption of the latter must be set the fact that it is impossible to carry expansion down to the condenser pressure; this is a factor that will need thoughtful consideration. But might it not be got over by operating it as a non-condenisng engine, utilising the heat from the exhaust in the feed water?

It is a debatable point whether the future will see cast iron holding its present position in the constructional details of steam engines. Many cases can be cited of casting failures where the final temperatures of the steam was only 500° Fahr., while on the other hand there are doubtless many plants using superheated steam of a temperature even higher than this, equipped with nothing but cast iron fittings and valves.

Some authorities hold that providing the cast iron contains a large proportion of steel in order to give it the necessary strength to resist the greater expansion strains involved, and is low in silicon content, there is little need for the employment of cast steel in the event of any reasonably high temperatures being adopted But doubtless this assumption would have been based on present day practice, and would not therefore hold good for the very much higher temperatures now in contemplation.

In piston engines of the double-acting type the question of cylinder lubrication will be all important in the event of higher steam pressures and increased superheat. It is questionable if the advent of pressures of from 100 lb. to 600 lb. per sq. in., together with a superheat of from 500° to 800° Fahr. will permit of the use of either slide or Corliss valves. The packed rod might also present insuperable difficulties. This then would lead us inevitably to the consideration of the single-acting type of engine; perhaps from the point of view of weight per horse power, and efficiency, the only logical design for these higher pressures.

Also important in piston engines is the question of cylinder lubrication. The greatest proportion of the lubricating oil now used in piston engines is required for the steam distributing valves; that actually required by the piston and piston rings being comparatively small. Consequently, the possibility of sufficient piston lubrication is not affected by higher initial steam pressures, because even in case of very high mean effective pressures in single-acting engines, where the piston serves as crosshead, and therefore requires constant lubrication, the piston can be made sufficiently long to keep the pressure per square inch within safe limits.

It thus seems clear that if we increase steam pressures to say 500 lb., or 600 lb., per sq. in. without using temperatures much higher than those employed in modern practice the more radical changes in design will be those requiring to be effected in the steam generator. But if we increase in the same proportion the existing degree of superheat—and this seems almost essential if the fullest advantages are to be obtained—then must the changes in design be much more comprehensive; and will exercise to the utmost the skill and judgment of engineers and power plant designers.

Electricity in Tin Mining.*

By D. M. W. HUTCHISON, B.Sc. and W. J. WAYTE.

(Continued from Vol. LXXXIII., page 746.)

HYDRAULIC MINING

Hydraulic-electric Mining.—Where economy in the use of water is necessary, or where the ratio of head to lift is less than about 5 to 1, making the economical use of elevators out of the question, or where the total head would be unnecessarily high for the monitors, it is usual to install gravel pumps and to use part of the available head for generating electricity to drive these pumps, the remainder being used for the monitors. The gravel pump is a centrifugal pump of special make (see Fig. 2) provided with renewable liner and wearing plates, capable of raising any stone which can enter its open-ended suction pipe. Its efficiency is naturally not high and figures for performance are hard to obtain, but Mr. J. J. Garrard in a Paper read before the Institution of Mining and Metallurgy in February 1917 gave an average annual efficiency of 27·25 per cent for a gravel pumping installation. As electrical losses were included the combined efficiency of pump and motor works out at about 42 per cent., the mixture pumped being about 5 per cent. solid by bulk. The figures of a well-known maker of these pumps are given in Fig. 3, and show an efficiency of 50 per cent. for the pumps under similar conditions or, including the motor, say 42·5 per cent., which

INDEX TO LETTERS AND NUMBERS.

A	Collar for water chamber.
B	Outside fibre washer.
C	4-Part bearing casing.
D	Cap for water chamber.
E	Bottom and side brasses.
F	Adjusting wedge for E.
G	Runner.
H	Inner fibre washer.
J	Door on suction side.
K	Liner door.
L	Wearing ring.
M	Stuffing box for turning pipe.
N	Liner.
O	Pump casing suction side.
P	Nipple.
Q	Gland on turning pipe.
R	Turning pipe.
S	Suction bend.
T	Top brass neck bearing.
U	Shaft side of casing.
V	Matching piece.
W	Set screws for adjusting wearing ring.
X	Water ring.
Y	Pinching plate.
Z	Set screws for adjusting liner
1	Delivery bend.
2	Nose-piece at bottom of suction.
3	Bed-plate.
4	Muff coupling.
5	Thrust collars.
6	Thrust collar plates.
7	Cap for thrust bearing.
8	Brasses for thrust bearing.
9	Stauffer lubricators.
10	Steam primer for pump.
11	Flap valve on delivery bend.
12	Base of thrust bearing.
13	Rope pulley.
14	Lighthouse lubricators.

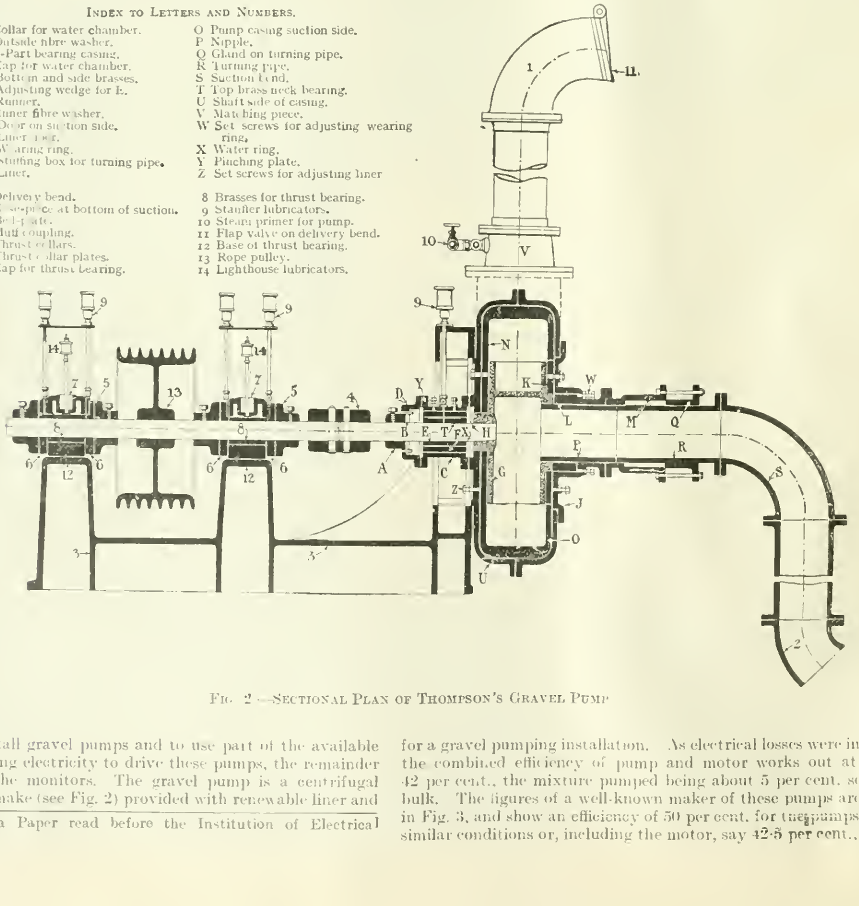

FIG. 2.—SECTIONAL PLAN OF THOMPSON'S GRAVEL PUMP

agrees very well with Mr. Garrard's result. As against this the efficiency of an elevator is given in Mr. Garrard's Paper as 16·58 per cent. The efficiency of the pump and pipe work may be taken at about 38 per cent., as against 16·6 per cent. for the elevator.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

Suction Dredging.—A suction dredge consists of a centrifugal pump to supply a monitor jet, together with a gravel pump to elevate the mixture the whole being mounted in some cases on a pontoon together with the necessary boilers and engines or, if electrically driven, motors. This pontoon usually rests on dry land, but is moved about to fresh places in the mine by floating it off. Many mines prefer to mount their pumps in a permanent position on concrete foundations, but the process is just the same and is, for convenience, called suction dredging in this Paper. The essential difference between this and other forms of hydraulic mining is the use of pumps both for producing pressures at the monitor and for elevating the mixture. It must be remembered that the water pumped is generally the effluent from the tailings dump, with perhaps a certain amount of clean seepage water mixed with it, so that a strong construction is more to be desired than a high efficiency pump, which would quickly be rendered useless by the grit in the water.

HYDRAULIC ELECTRIC SYSTEMS ANALYSED.

Where the hydraulic-electric system is contemplated there is a choice of methods.

Ground Sluicing and Gravel Pumping.—This method is occasionally used where there is a plentiful supply of labour and the necessary water close to the mine. The power for driving the gravel pumps need not necessarily be generated by falling water, but a comparison has been made which shows that, given a certain water power, 28 per cent. more work can be done by employing the water power to generate electricity to drive gravel pumps than by using it for elevators. The brake horse-power required to drive gravel pumps can be obtained roughly from Fig. 3. The usual mixture is about 5 to 7 per cent. The makers of these pumps rate them at so many cubic yards of gravel lifted per hour, but this method of rating pumps is crude and it would be far more satisfactory to rate them in their capacity in gallons of water per hour, considering that about 90 per cent. at least of the mixture raised consists of water. The pump works with a shallow open sump and a suction lift of 15 ft. or so, and delicate speed regulation is necessary to keep the water level in the sump constant.

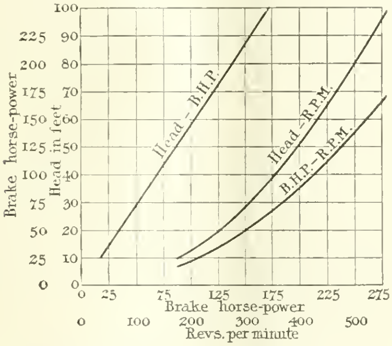

FIG. 3.—MAKERS' FIGURES FOR 10 IN. GRAVEL PUMP LIFTING 50 CUBIC YARDS OF SOLID PER HOUR.

It must be remembered in this and all other alluvial tin-mining practice that in very few cases can pumps be installed to suit their best performance and be kept at work in that position. As the mine develops, the pumps must be moved and conditions as to head and discharge are continually varying. What then is required is a motor that is capable of a large variation of speed together with fine regulation at any speed, and these conditions are in theory best fulfilled by direct-current motors coupled direct to the pumps. As, however, three-phase current is generally used owing to convenience in distribution it is the usual practice to drive the pumps direct or by belt by induction motors and to regulate the speed by rotor resistances. In some cases the motors are run at full speed and throttling pieces put in the delivery pipe, which has the effect of introducing artificial head thus cutting down the delivery. Both these methods are of course wasteful, but it is probable that they will continue in use in preference to the use of direct current. There are two or three small direct-current pumping plants which have given good results, but there is very unlikely to be any great extension in its use as in the future there will be a tendency towards group stations, thus involving three-phase working. In any case, however, where there is a possibility of installing a small compact plant close to the mine the advantages of direct current for most mining operations, especially pumping and hauling, would outweigh the disadvantages due to the slightly greater complication of brush gear and commutator. Variable-speed direct-current motors are in use in a colliery in the Federated Malay States under fairly severe conditions, and there is no climatic reason why they should not be used where it would be good policy to do so.

Divided-volume System.—Here the cutting is done by jets of water under natural head directed on to the working face by monitors, the size of the jet being usually about 2 in. diameter. The whole of the available pressure water is piped to the mine and there utilised partly to supply monitors and partly to generate electricity for the purpose of driving gravel pumps to elevate the mixture cut by monitors. Elevator and hydro-electric cum-gravel-pump efficiencies have been taken at 16·6 and 23 per cent. respectively throughout, and although this assumption of constant efficiency over the whole of the curves may not be justifiable the error is not likely to be large.

The question of gravel pump versus hydraulic elevator may not depend on efficiency alone; where waste of water is unimportant the hydraulic elevator will score owing to its low capital and maintenance costs. There are, however, certain advantages in the use of gravel pumps which may weigh heavily; for instance, if the ratio of height of lift to head is too low it becomes necessary to elevate in two lifts, and this is such a wasteful operation for hydraulic elevators that it is practically out of the question except on a small scale for working small pockets. The gravel pump is capable of a maximum lift of about 100 ft. although it loses efficiency, except in the largest sizes, at lifts much over 70 ft.; but pumping in two lifts by gravel pumps, where necessary, is hardly less efficient than pumping in one, whereas to use elevators in two lifts is an exceedingly inefficient process as the higher elevator has to take not only the monitor water but the lower elevator pressure water as well, so that the proportion of the elevator to monitor water may be about 2½ to 1, and the efficiency of the process, even under favourable conditions, about 9 per cent.

Divided-head System.—In many cases the water available for working the mine has to be piped long distances from a comparatively high elevation. It is found in practice that in most classes of ground worked that there is no economy in using pressures higher than about 200 lb.; in fact, most hydraulicing is done at pressures considerably less. Where the pressure is too high the ground is cut away too quickly and the resulting mixture of ground and water has to be thinned down by the addition of more water to a consistency which will flow towards the sump and will not block the pumps. This extra water is supplied in most cases from the monitors; consequently the amount of ground cut may be said to vary with the quantity of water used irrespective of the pressure, provided the pressure is sufficient to break up the ground. On this account it is the usual practice where a high fall is available to use the first part of the fall for generating electricity, which is transmitted to the mine for driving gravel pumps. The remainder of the fall is used for monitors, and as of course all the water which passes the Pelton wheels in the electric power station goes on to the monitors, this may be called the divided-head system. Speaking generally, for the height of lift usual in practice (50 ft. to 70 ft.) heads of 600 ft. and over are suitable for this system. No comparison with the hydraulic elevator has been made in this case, as where the fall is high enough to suit the divided-head system it is too high to be economical for hydraulicing.

Suction Dredge System.—A system involving the conversion of water power into electric power, which is again converted by the mechanical agency of a pump into water power for hydraulicing naturally cannot compete in efficiency with the use of water power direct for the same purpose except under extraordinary conditions, so that this system is rarely used in conjunction with hydro-electric schemes. With very high heads, however, it may not always be convenient owing to the nature of the country, to use the divided-head system, in which case nozzle pumping is the only feasible alternative. The suction dredge system has been used so far in this country chiefly in conjunction with steam plant, although the biggest installation of the kind at present in use derives its power partly from a hydro-electric and partly from a Diesel electric station. Unless there is a large amount of seepage water which must be removed from the mine in any case, it is usual to pump the same water over and over again with a period for settling, the return water from the tailing dump being led to the suction side of the nozzle pumps and thus providing a certain proportion of natural head to the monitor.

BUCKET DREDGING.

Bucket dredging is a form of alluvial mining which has become very popular in the Federated Malay States during the last few years, and will doubtless become more so, as the richer and more easily worked alluvial deposits become exhausted. By this means low-lying tin-bearing land of low grade can be worked at a profit which would not be practicable by any other method. At the present time 17 dredges are operating in the F.M.S., only one of which is driven electrically, so that with a cheap supply of power tin dredging should open a wide field to the electrical engineer. Land most suitable for bucket dredging is that met with in the neighbourhood of Taiping, where at the present time seven machines are operating all within a radius of 3 miles from Taiping. The tin-bearing ground is a gravelly wash, which is easily dug and treated, of an average depth of 45 ft. below the surface. At this level a bed of hard clay is encountered which does not carry tin. The Kinta Valley, further south, is a more difficult problem as the bottom is of irregular limestone, the pinnacles in some places rising to within a few feet of the surface and the depth varying to 70 ft. or more. The best values are, moreover, usually on the limestone, so that the dredge and machinery must be of very robust construction to withstand the severe shocks which are of frequent occurrence

(To be concluded.)

Mercury Arc Rectifiers for Large Outputs.

GENERAL PRINCIPLES.

Since the mercury arc rectifier entered the field of industrial application its theory, as well as its general construction, have been the subject of numerous publications. It will, therefore, suffice on this occasion to recall briefly the principle involved.

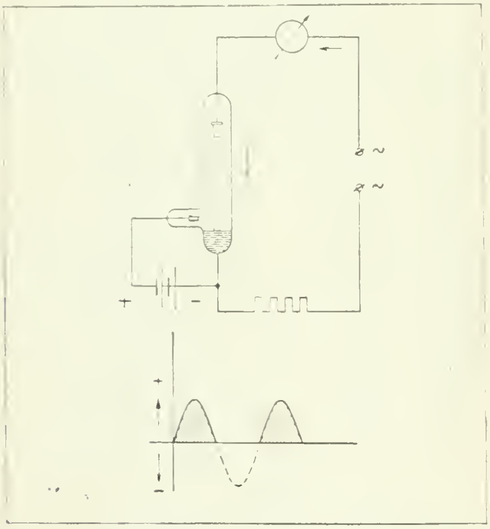

FIG. 1.—ELEMENTARY MERCURY ARC RECTIFIER.

The mercury arc rectifier is used to convert alternating current into direct-current. Its principle is based on a property possessed by the mercury arc (discovered in 1902 by Mr. Cooper Hewitt) which can be demonstrated as follows: In Fig. 1 is shown an exhausted tube of glass or quartz with one mercury electrode and one solid electrode of iron or graphite. If the terminals of the electrodes are connected to an alternating current supply, no current will pass, because the resistance of the circuit is practically infinity. Suppose that by suitable means a direct-current arc is started having the mercury electrode as the negative pole and the auxiliary electrode, shown on the left in Fig. 1, as the positive pole. It will then be found that with regard to the alternating current supply, the arc so created transforms the apparatus into an electric valve, that is it allows current to pass only when the solid electrode is an anode, the flow of current being checked when the solid electrode is a cathode. One half of the alternating current wave will be able to pass, the other half will be intercepted, and direct-current supply is obtainable in the circuit of the principal electrodes. (*See* the lower part of Fig. 1.) It is necessary for the successful working of the apparatus for the mercury cathode to be at a high temperature, the temperature of the anode being that corresponding to dark red. These conditions are fulfilled by the mercury arc working in a vacuum, for the specific density of the current at the cathode is very high while at the anode, since the arc spreads itself over a large surface, the current density is relatively low.

In the elementary apparatus above referred to, an auxiliary arc is employed to maintain the temperature of the cathode at the required value. This arc becomes superfluous and an uninterrupted passage of direct current is obtainable if several anodes connected to a polyphase source of supply and thus operating alternately with the same mercury cathode, are used, and if the current at the mercury cathode never falls below a minimum of 3-5 amperes. The working of each solid electrode will in such cases be intermittent, but one of them at least is always an anode, and the arc passes successively from one electrode to the other without any interruption at the cathode.

EARLY COMMERCIAL DEVELOPMENT.

These "vacuum-tube rectifiers" of Mr. Cooper Hewitt have been known since 1902. As constructed commercially such a rectifier consists of a hermetically sealed glass vessel with the mercury cathode in the lower part and having two or three side extensions in which the iron or carbon electrodes are located (*see* Fig. 2). The glass vessel is exhausted as completely as possible, and experience has shown that the vacuum is sufficiently maintained for several thousand hours of use. The current capacity of such rectifiers is limited by the maximum permissible size of the platinum leading-in wires, but nevertheless they have been successfully constructed for currents up to 100 amperes (continuous rating), after which an increase of capacity is only obtainable with a reduction in the life of the apparatus. Such rectifiers have been extensively used in America with excellent results for battery charging, for the supply of small motors, and for supplying arc lamps in series. It is noteworthy in the case of the last-mentioned application that a direct-current output up to about 50 kw. has been obtainable from single rectifiers, the dimensions of which approximate to those of a large glow lamp.

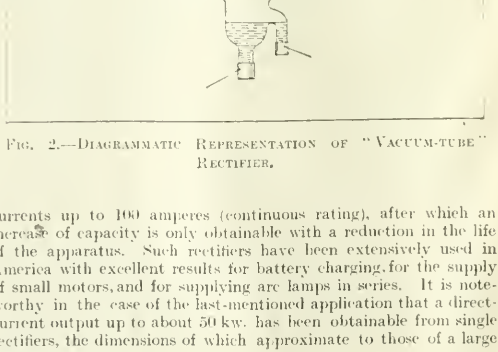

FIG. 2.—DIAGRAMMATIC REPRESENTATION OF "VACUUM-TUBE" RECTIFIER.

Fig. 3 represents a diagram of the connections usually employed with apparatus of the above class. The neutral point divides the secondary winding of the transformer into two parts which work alternately. This point becomes the negative pole of the direct-current system, the mercury electrode being the positive terminal. The waves of current are smoothed out by placing reactance coils between the transformer secondary and the anodes, as well as in the direct-current circuit. The reactances in the circuit of the anodes allow the rectifiers to operate properly in parallel with one another and with other sources of direct-current supply.

The losses in the mercury arc rectifier are equal to the product of the current and the pressure drop across the arc. It is noteworthy that the latter is independent of the current value—it varies from 13 to 20 volts, according to the pressure at the terminals. The losses, therefore, for a given working pressure are equal to the load current, multiplied by a constant, this constant being the volt-drop across the arc, so that the efficiency of the rectifier is the same for all values of load current. The drop of pressure across the arc increases very little as the distance between the electrodes becomes greater, and even in the case of working at high pressures, where the distance between the electrodes is necessarily large, the volt-drop across the arc does not greatly exceed that of rectifiers working at low pressures. Consequently the efficiency of rectifiers operating at high pressure is very high—for instance, at 500 volts, an efficiency of 95 per cent. can be obtained, which remains practically constant down to very light loads.

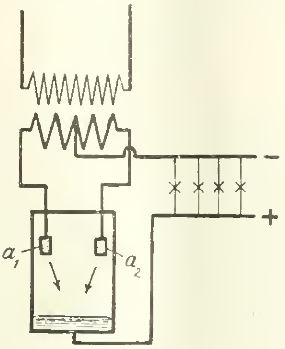

Fig. 3.—Diagram of Connections for Mercury Arc Rectifier Equipment.

Rectifiers for Large Outputs.

The favourable results obtainable with apparatus of low output encouraged the Société Anonyme Brown, Boveri & Company to investigate the question of building rectifiers for large outputs. A "Rectifier Company" was formed by the firm in 1912 in Glaris, Switzerland, for the purpose of carrying out the necessary experimental work, and the technical staff of this company soon made the acquaintance of numerous difficulties of a practical nature. The first serious difficulties arose from the necessity of constructing large metallic chambers sufficiently gastight to enable a vacuum of 0·02 mm. of mercury to be maintained. Then the insulated terminals for the conductors carrying the current to the electrodes required the invention of joints which should be perfectly gastight. It is true that in the field of radiography a similar problem has had to be solved, but the solution adopted in that case is only applicable to apparatus of small dimensions. Again, it was necessary to provide means for preventing short circuits between the anodes, which may occur when an arc is started between two fixed electrodes. The Cooper-Hewitt rectifiers had already revealed the possibility of such short circuits, which can occur when an anode is not working properly, and as the output to be converted increases, the chances of short circuits between the anodes increase also. It is possible to prevent them by carefully choosing the position of the electrodes in the apparatus and by compelling the arc to follow a predetermined path with the aid of shields and suitable guides. Another danger that had to be guarded against consists in the discharges which may occur between the anodes and the neutral substances in the interior of the chamber; the latter may cause a black deposit in the rectifier and rapidly put it out of order.

The above and various other difficulties met with in the earlier

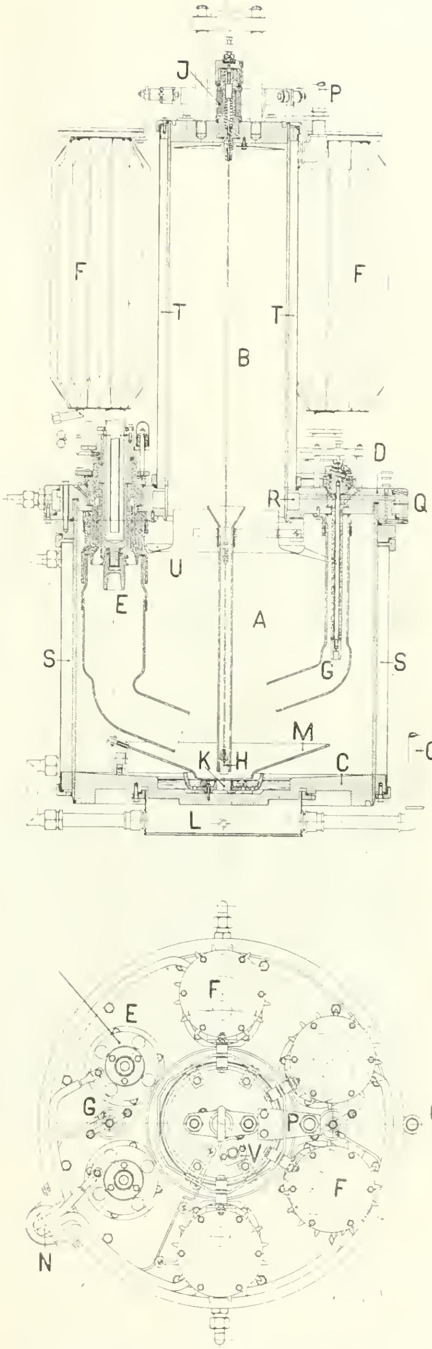

Fig. 4.—Diagrammatic Representation of a Mercury Arc Rectifier for outputs above about 150 kw. (1915 Type).

A Arc chamber. B Condensing cylinder. C Base. D Ring carrying anode E Principal anode. F Anode cooler. G Exciting anode. H Ignition anode J Ignition solenoid. K Mercury cathode. L Cathode cooler. M Cathode dish N Cable support. O Inlet pipe for the cooling water. P Outlet pipe for the cooling water. Q Exterior cooling channel of the anode carrying ring. R Interior cooling channel of the anode carrying ring. S Cooling jacket of the arc chamber. T Cooling jacket of the condensing cylinder. U Collecting channel for the condensed mercury V Pipe connection to vacuum pump.

attempts of the Rectifier Company to construct thoroughly reliable rectifiers of large output have now been completely overcome.

Construction of the Brown, Boveri Rectifier.

Fig. 4 shows the construction of a 1915 pattern Brown, Boveri mercury arc rectifier for large output. The rectifier consists of a circular chamber having a cylindrical extension at the top wholly built of steel plate; the base and the cover of the chamber are made of thick steel plates. The mercury cathode is contained in a recess in the base, while the cover is perforated to receive the six principal anodes, and the two auxiliary anodes for the excitation of the rectifier. The cylindrical extension acts as a condensing chamber for the mercury vapour which arises from the cathode, the condensed mercury returning in the form of small liquid drops to the cathode, which is thus continually replenished. The cover of the condensing cylinder carries a solenoid for controlling the ignition anode, and a screw ring for lifting purposes. The plate carrying the anodes is secured to the lower chamber by screws and can easily be dismantled. This construction simplifies the erection and dismantling of the rectifier. To prevent the discharges which may occur between the anodes and the parts of the chamber which are adjacent to them, the arc and the anodes (in this design) are surrounded by protecting tubes of insulating material. As the arc leaves the tube it is guided into a wide funnel or dish which terminates a few millimetres from the surface of the cathode.

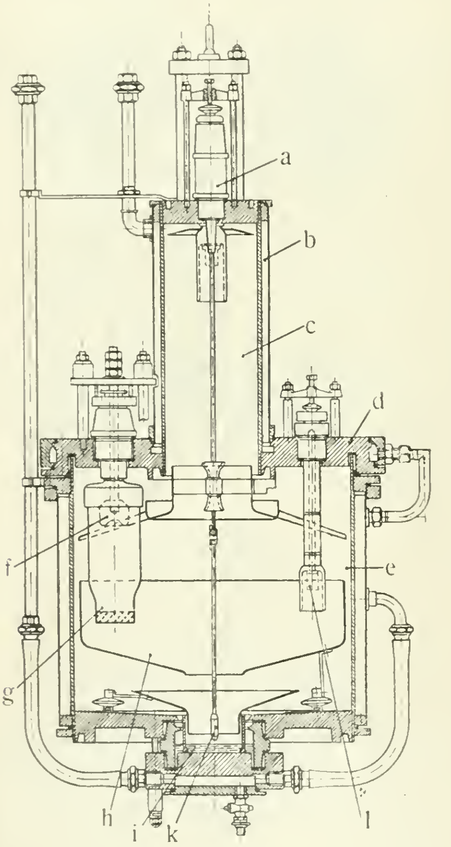

Fig. 5.—Diagrammatic Representation of a Mercury Arc Rectifier for outputs up to about 150 kw. (1917 Type.)

- *a* Ignition solenoid.
- *b* Water-jacket.
- *c* Condensing cylinder.
- *d* Cover carrying anodes.
- *e* Arc chamber.
- *f* Anode.
- *g* Anode cover.
- *h* Arc collector.
- *i* Cathode.
- *k* Ignition anode
- *l* Excitation anode.

Details of a Later Design of Rectifier.

Fig. 5 shows a more recent design of rectifier cylinder of the smallest size manufactured, in which water cooling of the anodes can be dispensed with. The rectifier chamber is insulated from the cathode, which adds to the reliability of the apparatus, while the anodes are completely surrounded by pressed steel cylinders the lower ends of which are not completely open, but are partly closed by baffle plates set at an angle. One of the most important constructional features connected with the design of these rectifiers is the means provided for maintaining the cylinders gastight at the leading-in insulators carrying the anodes and their terminals. For this purpose mercury seals are used, the design of which is illustrated diagrammatically in Fig. 6, and experience has shown that the good qualities of this class of seal are such as to warrant the statement being made that the problem in question may be said to have been completely solved.

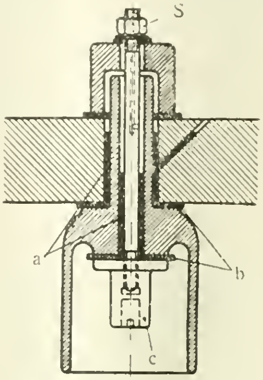

Fig. 6.—Diagrammatic Representation of Anode and Mercury Seal.

a Mercury. *b* Asbestos. *c* Anode.

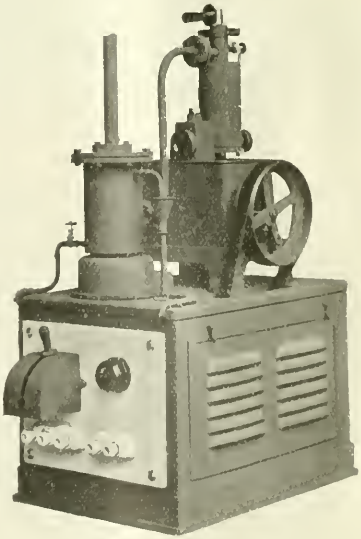

Fig. 7. Air Pump Equipment.

Figs. 4 and 5 show how the cooling of the various parts of the rectifier is carried out. The arc chamber is provided with a water jacket, while cooling water also circulates around the condensing cylinder, the cathode, and the cover carrying the anodes. Further, in all but the smallest size of rectifier, the anodes are cooled by means of ribbed cylinders (containing water) surrounding their upper extremities. In the case of rectifiers working at less than 600 volts D.C. pressure, and provided that both poles are insulated, running water from the mains may be used if it is of suitable quality. In all other cases a self-contained cooling system is installed, consisting of a radiator located in a convenient position, and a pump.

To start the principal arc, a small arc produced by direct current is struck between the ignition anode *h* and the mercury cathode. This ignition anode is controlled by a solenoid *j*, which acts on a soft iron core, connected to the anode by an iron rod. In its normal position the end of the starting anode is 10 mm. above the surface of the mercury. To start up the apparatus the ignition anode must be lowered until it touches lightly the surface of the cathode. By this contact the arc striking circuit is closed, and the current passes through the ignition anode and the mercury cathode. The former is then raised, and at the rupture of contact a small arc is produced, which immediately starts the working arc between the main anodes and the mercury cathode. When the variations in the load supplied by the mercury rectifier are considerable, auxiliary exciting anodes must also be used; these anodes require a current of 5 amperes. In general the load is sufficiently constant, and such excitation arcs are not required.

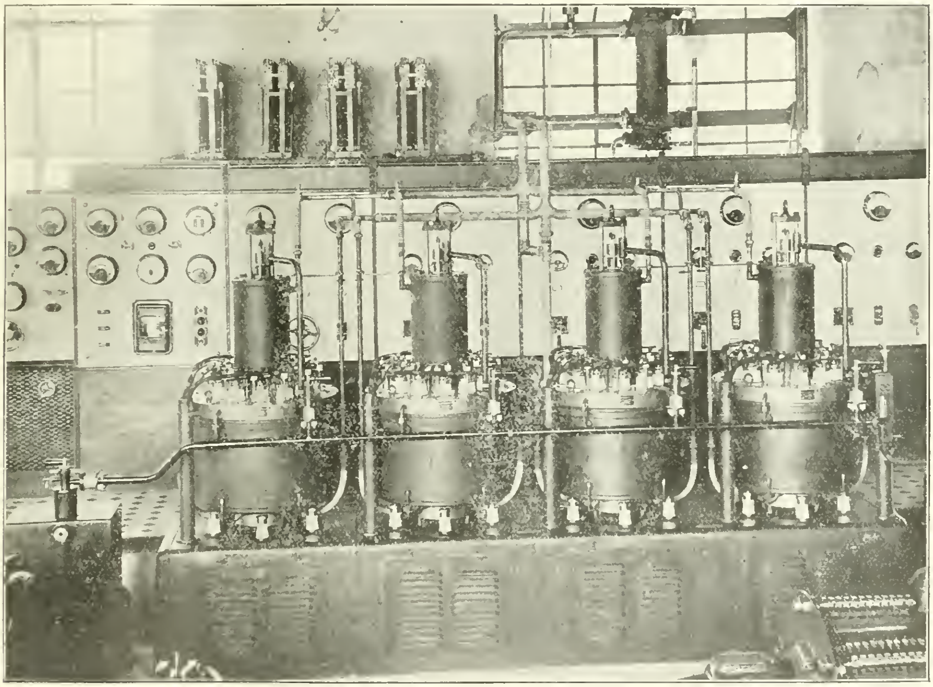

Fig. 8.—Rectifier Equipment at Le Locle, Switzerland, for 500 kw., 320 volts Direct Current.

A vacuum is created in the arc chamber by means of a two-stage vacuum pump, which is an essential accessory to each installation; with these pumps a vacuum of 0·005 mm. mercury is obtainable. After a rectifier has been a few months in service the mercury seals are properly formed and the cylinders are then hermetically sealed.

Further operation of the vacuum pump is not required as a rule—any slight decrease of the vacuum which may be observed when the apparatus is not on load, is compensated under working conditions by the absorption of the gases by the arc. The vacuum pump has been so designed that it requires no supervision during operation, and as no oil can escape from it should the pump stop accidentally, service interruptions caused by oil escaping from the pump and thus allowing air to penetrate into the rectifier are avoided.

The actual degree of vacuum varies between 0·01 and 0·1 mm. of mercury, and it is sometimes found in practice that an electrical method of measuring the vacuum is preferable to the use of the McLeod vacuum gauge. One such method is that of measuring the resistance of a wire, the resistance of which increases considerably with the vacuum; another method consists in measuring the difference of pressure between an auxiliary anode and the cathode. For small currents, the resistance between the auxiliary anode and the cathode depends principally on the vacuum, so that a voltmeter connected across the transformer and suitably calibrated will indicate at any time the state of the mercury vapour and the vacuum. Such electrical methods of measuring the vacuum allow the vacuum indicator to be fixed on the switchboard.

Standard Sizes of Rectifier.

As the internal construction of this class of rectifier remains practically unchanged for working pressures between 110 and 800 volts, a few standard sizes graded in accordance with the current output—cover a wide range of requirements. Up to the present two sizes have been completely standardised, namely, type G 3/6 for 250 amperes, and type G 4/6 for 500 amperes continuous rating. Larger outputs have so far been dealt with by employing a suitable number of cylinders in parallel. These two standard types can be readily arranged for use with higher pressures up to 1,200 volts, while (based upon test-room experience) it can be said that with unimportant modifications, pressures up to 2,400 volts can be dealt with. A third standard size, type G 5/6 for 1,000 amperes 750 volts continuous rating, is now in course of construction.

Fig. 8 is an illustration of a typical rectifier equipment for 500 kw., consisting of four cylinders, type G 4/6, one being spare. The aggregate capacity of the rectifiers already supplied, or under construction in the Baden works of Messrs. Brown, Boveri & Co., amounts at the present time to over 30,000 kw.

The Influence of War on Engineering.*

By Sir E. H. TENNYSON D'EYNCOURT, K.C.B.

During the war material of all sorts had to be produced in the quickest possible time, at any cost, though as far as the Admiralty was concerned everything possible was done to keep down the cost, provided no delay was occasioned and no stoppage of work occurred. Now, although equally big production is necessary, economy must be strictly observed in everything and our costs must be reduced to a minimum. If this is not done it is only a question of time before a rude awakening to the fact that we have lost our market will make itself manifest in a very disagreeable way. War has taught us the advantage of standardisation for bulk production, but it must always be borne in mind that standardisation tends to keep back the introduction of the most up-to-date improvements. One must, therefore, make up one's mind to standardise for a time and be always preparing to make a big stride embodying the future improvements and then suddenly jump from the old standardised article to the improved one, which again must be standardised until it is decided to take another step forward. Now is the time to make proper use of the knowledge we have gained during the war. Unless we do so others will get in front of us, and it seems to me that in the next few years the engineers of this country will be called upon to play a part which may be a deciding factor in the future prosperity of the country. With the tremendous shortage of manufactured articles at home the home demand will keep our industries well occupied for a number of years, and if we are, therefore, not careful to foster our foreign trade we shall lose the foreign market, as it will be difficult to supply that as well as the home market. Production must be therefore so increased that we can not only keep our home market but retain our foreign market, of which we shall have need within a certain number of years when the home demand will not be sufficient to employ all our factories. Before the cost of the materials, whether manufactured or raw, can be at all stabilised labour questions must first be brought to the same condition, and I would urge all engineers to study this question in all its bearings and to try and arrive at a friendly understanding between those in authority and those who are working under them. Special care should be taken to find out the point of view of the workman and all concerned. I look forward with much more confidence to this method of arriving at a good understanding between the employer and employed than to the adoption of profit-sharing and similar schemes. Without a proper atmosphere of sympathy in works and factories all such schemes are more or less artificial, and when a better feeling has been established there will be then comparatively little difficulty in starting schemes for the benefit of all. The war has shown us how splendidly all classes can work together with one great end, and the spirit of unity of purpose which produced munitions must be carried on in the realm of production with a great view of increasing our prosperity. There is no question that engineers of this country and particularly the younger men can do an immense deal to help on this great object.

The Success of the Geared Turbine.

The outstanding feature in the engineering manufacturing world during the last five years has been the huge production of war material and the means adopted have been most interesting, indicating the wealth of engineering talent available in the country. As far as the Navy in particular is concerned, in marine engineering, which has already reached a high standard, the full capacity of the country was required for quality and rapidity of output. This might be expected to retard progress, but there were some notable exceptions, especially the combination of the high-speed revolution of the turbine, with the more efficient slow-running propeller by means of mechanical gearing. As a result of one or two preliminary ventures, the geared turbine design was adopted for destroyers, light cruisers, patrol vessels and battle cruisers with most gratifying results. For some time past it has been the recognised type of machinery for all classes of our warships, and has proved itself to be in all respects reliable for our requirements. By its use on destroyers it has not only been possible to save weight and space, but to increase the propulsive co-efficient from 40 to 60 per cent. No enemy ship was fitted with mechanical geared turbine although the Fottinger hydraulic transmission system was used. Other forms of hydraulic transmission have been devised by British inventors, and have proved superior to that mentioned. The Hele-Shaw hydraulic clutch is a case in point.

Value of Electric Transmission.

Another form of transmission which has come into prominence is the electric transmission, which has been adopted by the United States Navy with considerable success and on a smaller scale in our own Navy. Although it would appear to offer few advantages and some decided disadvantages for full power working, yet it may prove of considerable value when it is borne in mind that warships steam for perhaps 90 per cent. of their power at sea at a small fraction of their full power. Our largest class of submarine, the K-boats, were a very interesting example of the type of different methods of drive to meet the necessities of the case. Steam turbines were provided for surface work, and electric drive under water, while a Diesel engine for use just before diving or just before coming to the surface was also installed. Transmission from the Diesel engine was through the electric motors so that these vessels have not only geared turbine for the steam drive but also electrical transmission with a Diesel engine and electric battery drive when under water. It is interesting to note that during the war more than 400 vessels burning oil fuel only in their boilers and with an aggregate of some 12 million horse-power were completed for H.M. Navy.

An interesting innovation which was introduced into our warships was the single collar thrust block known as the Michael thrust block. This allows economy in lubricating oil, a gain in efficiency and a saving of space. Advances in auxiliary machinery is indicated by the recent efforts to adopt rotary driving to this class of work. A noteworthy example being the close feed system evolved by Messrs. G. & J. Weir, which will lead to decided diminution in the corrosion of boiler tubes, though much work has yet to be done in this direction. As regards the adoption of the internal combustion engine, whilst immense strides have been made with the lighter petrol burning types for aircraft and land service we have not made the same progress with heavy oil engines. The Germans got ahead of us during the war, but we hope to be able to show a British-designed and British-made engine of the fast running type superior to their best now existing. The problem of employing Diesel engines for high-power installations is a difficult one. The successful low-speed installation in merchant ships now develop 400 to 700 horse power per cylinder, and the number of cylinders necessary for a large aggregate power is so considerable as to make the arrangement in a ship almost impracticable, while the weight of such installations, being as much as 250 lbs. per horse-power, is quite prohibitive in any type of warship. Lighter fast running engines are available, but the power per cylinder is much less than in the slow-running type. When it is realised that the total machinery installation in our destroyers weigh only 30 to 35 lbs. per horse-power, and that in a large power, modern battle cruiser this figure is as low as 20 lb. per horse-power the difficulty of adapting any engine of such a type to warships is apparent.

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* Abstract of a Presidential Address delivered to the Junior Institution of Engineers.

Heating and Cooking Notes.

A Review of 1919 and the Possibilities for 1920.

The war gave an immense impetus to electric cooking and heating. Apparatus was in demand not only for direct war purposes at sea or in the field, but also for canteens installed in munition factories, and for a number of industrial processes associated with the manufacture of munitions. The armistice, therefore, did not cause the same dislocation of work for manufacturers of heating and cooking apparatus that it did in connection with many other industries. It is true that war orders ceased, but the manufacturer could have more or less easily commenced the manufacture of peace-time products. It is, therefore, a little disappointing that further progress has not been made during 1919. There has been too much talk of the fear of an invasion of American apparatus, and too little done in the form of active preparation to cater for the home and the large Colonial market that exists. Given a manufacturer possessed of the necessary vim and pluck we can produce in this country apparatus every bit as well designed and made as the American product. Only hitherto we have tackled the problem in the wrong way. Apparatus has been made in comparatively small quantities and then put on the market to ascertain what defects were found during service. Then another small batch would be made incorporating improvements and modifications designed to remedy faults revealed in the first design. Some firms even advertised that they invited engineers to purchase and try out new apparatus and report their opinions to the manufacturer. Is it fair to ask the public to try your goods and give you the benefit of their experience ?

The American manufacturer thoroughly tests out a piece of apparatus before putting on the market, such tests being made not only in the test room and laboratory, but supply engineers and other users are paid to test the apparatus under normal working conditions. After these reports have been considered the final design is decided upon, and a large quantity made to this standard design. The quantity manufactured is determined from carefully prepared statistics supplied by the selling organisation, and no modifications are made in design until the bulk quantity has been disposed of. The result is a thoroughly sound article at a reasonable price.

One or two laudable attempts have been made since the armistice by British manufacturers to replace the American Table Cooking Apparatus, and certain forms of ovens by British made articles. The failing point seems to be the question of bulk production. It is questionable now that the restriction of certain imported articles has been proved illegal whether we are really in a position to meet American competition. Had we been really prepared to make such apparatus in bulk we need have had no doubt on the matter, because labour troubles in America would have provided the necessary breathing time for the final completion of plant for bulk manufacture made and started upon after the armistice. As it is we shall probably find an inrush of imported articles will occur during 1920, and there will be the usual clamour and groans from the British manufacturer that unless tariff protection is provided the industry will sink. The future home and colonial market for heating and cooking apparatus will be very large provided it is cultivated and developed, but it is up to the manufacturers to do their share of the cultivation. Improved methods of selling and mass production are far more healthy and effective weapons with which to tackle foreign competition than tariffs are.

We quite realise that during the past twelve months there have been many difficulties in the way of progress. Labour troubles have been frequent, and the moulders' strike is still hampering the industry. Material has been difficult to get, and transport delays have seriously retarded output. Supply authorities have suffered from four to five years' delay in making extensions to plant, with the result that supply engineers connected with such authorities have not been keen to obtain industrial or even private heating installations in their area. The Electrical Development Association promises well for the future, but its activities have hardly been felt during 1919. Very energetic efforts will have to be made by all parties, supply authorities, contractors, and manufacturers, in the future if this important section of the industry is to progress as it should. New housing schemes offer a good opportunity of driving home the value of the all-electric method for household economy and convenience.

NEW APPARATUS IN 1919.

Many new pieces of apparatus have been described in these fortnightly notes during the past year, a number of which have been made by newcomers to this branch of the industry. Firms branched out into this class of work owing to the demand that occurred during the war period. Messrs BELLING & COMPANY have produced, in addition to their well-known lines of cookers and heaters, a well finished set of table cooking accessories, such as warming plates, kettles, toasters, &c. The BASTIAN COMPANY exhibited a new design of radiator at the shipping exhibition. The same firm have also produced an electric water heater. The QUAIN ELECTRIC COMPANY have produced a very efficient immersion heater both for household and commercial purposes, together with a hot water geyser. A series of radiant electric fires, and a hot water radiator, in which the source of heat is a "Thermaglo" immersion heater fixed in the base. Messrs. CREDENDA CONDUITS have contributed their share toward progress in the form of an electric oven in which particular attention has been paid to thermal insulation. The SUN ELECTRIC COMPANY and the ENGLISH ELECTRIC COMPANY are each represented by an electric fire. Both Messrs. BELLING and the JACKSON ELECTRIC STOVE COMPANY have designed and produced a sheet metal type of oven with lagged frame, and mounted on legs to bring the oven to a convenient height. Various firms have produced bowl type fires for auxiliary heating which consume 500 to 600 watts, and can be used both as a fire and as a radiant hotplate. The majority of makers now include industrial type radiant heaters for use in factories and workshops amongst their list of manufactures. Messrs. FERRANTI, LTD., have ceased to manufacture heating and cooking apparatus, and the designs of this pioneer firm have been taken over by the JACKSON ELECTRIC STOVE COMPANY, LTD.

Thus the various manufacturers have not been idle, but we hope before another year passes that production will be increased and some form of standard element agreed upon. Standard sized plugs are another necessity. We are glad to be able to record that rotary snap switches are now made in this country, and there is no necessity for manufacturers to use the American variety. There seems to be a tendency for switchboards for cookers to be made up without indicating lamps. This we think is a mistake, an indicating lamp for the oven, hot plate, &c., affords a valuable means of effecting economy in the use of cooker, and seeing that supply engineers have to face the consumer if the bill for electrical energy is high, we wonder that they do not exert influence on manufacturers to provide indicating lamps. The I.E.E. rule that all heaters should be wired so that there is always one element uncontrolled on the radiator switches does not seem to meet with universal approval. One very large supply authority declines to purchase heaters designed in compliance with this rule.

The electric hot-water radiator seems likely to replace and finally oust the conveeter type. The former has certainly a large field of service in factories where inflammable gases and materials are used in garages and in theatres. One London theatre has during the past year installed a number of these heaters throughout the theatre and dressing rooms. There still exists amongst manufacturers a certain diffidence in supplying information for publication. That new installations and new apparatus should be described is for the good of the industry as a whole, and the manufacturers in particular, and we hope that during 1920 we may have the pleasure of regularly receiving information concerning the activities of manufacturers of heating and cooking apparatus. We also hope to hear from supply engineers concerning progress made in developing electrical heating and cooking in their area and particulars regarding industrial and other large installations.

Scientific Management: A Solution of the Capital and Labour Problem.

We give below an account of the discussion which took place at Glasgow and Birmingham on Capt. J. K. Scott-Maxwell's Paper on "Scientific Management: A Solution of the Capital and Labour Problems." An abstract of the Paper was given on p. 716 of our issue of December 19, 1919.

Mr. ARCHD. PAGE said that the first thing was to arouse the interest and gain the support of the unions for the scheme proposed in the Paper. The good will of the workers was the essence of successful management. There was growing evidence of a more sympathetic attitude on the part of employers. Much spade work would require to be done before the British workman would agree to become an automaton for the sake of the satisfaction of knowing that he was completing his job with the minimum of effort.

Mr. J. H. BUNTING said he did not agree that the establishment of National Boards was the first step. Employers themselves must do something before they could enlist the interest of the Government. He had seen remarkable results effected by the introduction of scientific management. While the whole country required educating on the question, he was convinced that the employer more than the workmen required education.

Mr. MORRISON said he wondered how many of them had considered that if they could manufacture four artices and paid 2s. 6d., getting for themselves 150 per cent., they could afford to pay 3s. 6d. Higher wages obviously meant increased production, and they must frankly tell the workmen that scientific management did not mean getting something for nothing. They must have records on a scientific basis. The management staff needed to be educated, and all concerned must be convinced that the principles upon which business was conducted were equitable. If employers did not move in the matter of scientific management, organised labour would step in and force their hands.

Mr. T. C. HERBERT said the author had not put the humanity aspect of the subject strong enough. They must substitute help and assistance in the functional foreman for mere bullying and driving. The whole burden of Mr. W. R. Cooper's recent booklet on Capital and Labour was a plea for co-operation. Scientific management eliminated waste in material and human energy; but its foundation was an alteration of the attitude of the employer to the employed. He hoped that the author would be able to do something to convert the labour leaders to his views.

Major H. RICHARDSON said that the B.E.A.M.A. might initiate an investigation into the problems which they were considering.

Major J. S. NICHOLSON said that at the Glasgow University they had now a lectureship in engineering production, and that would be of great value to the large number of engineering students.

Mr. JAMES RICHARDSON said they realised the difference of attitude to the subject at the present time as compared with 1914. The application of the principles advocated in the Paper was the best means of staving off the crises in industry with which they were threatened, and must look to the technical institutions and the universities to provide the right kind of staff officer for the future.

Mr. J. H. HUNTLEY said that the National Boards should start from the workshop. The ignorance of employers, he thought, was largely due to their leaving the settlement of industrial disputes to lawyers acting as secretaries of employers' combinations.

Mr. J. M. JOCKEL said more could be done on the elementary side of scientific management. He advocated an extension of the suggestion box as a useful link between employers and workmen. Much could be done in constructional matters in the works through standardised technical knowledge.

Mr. W. KEACHIE said that much advocated in the Paper was already in practice in certain workshops, although it was not called scientific management. The spirit in which suggested improvement was introduced was the main thing. If anyone went through their factories to-day he would see wide open doors by which production could be increased by tightening up the management and improved methods

Mr. C. J. Booker said that the present system of training apprentices was bad. The lads should from the outset be taught on proper practical lines, for what apprentices first learned was apt to abide with them.

Mr. J. F. Neilson drew attention to an important Paper on the subject read before the American Society of Naval Architects two years ago entitled "Naval Construction."

Captain Scott-Maxwell, in reply, said he had been in American factories where the system was in operation, and the best possible relations existed between the management and the workers. He did not agree that the system made machines of men. A man was not made better by doing unnecessary work. It was rather demoralising to do useless work. Training a man's mentality did not turn him into an automaton. The B.E.A.M.A. were practically debarred from taking up the question, as the Federation of British Industries held that labour and wages questions were their preserve. In America they found it required some six years to train a staff to work the system, and it would not take less time in this country. Unless they had something like National Boards, there would be a great waste of effort in evolving the proper application of the system in this country. Mr. Galbraith, in America, had found that cinematographing of processes enabled men to be instructed in bulk, which was more rapid than giving individual instruction. Scientific management was due to the accuracy of measuring instruments, and it was simply the same idea applied to the measurement of human effort.

DISCUSSION AT BIRMINGHAM.

Mr. A. Phillips said he was a firm believer in the application of scientific management as a means of obtaining that increase in production so essential at the present time. Capt. Scott-Maxwell appeared to consider that "Taylorism" was the only solution for all the troubles; but he (the speaker) was inclined to think that Taylor scarcely visualised the conditions that were bound to obtain under what was recognised at the present time as "mass production." The end and aim of scientific management was to produce the maximum amount of work with the minimum amount of effort, not only physically, but also mentally. The subdivision of work to such an extent that the people employed in it had only to learn one simple motion and to continuously repeat it in order to do this work was a condition which was not calculated to stimulate the brain. It was obvious, contrary to some opinion, that the number of skilled workers, instead of being less, would be greater in future; they would, however, be engaged in producing the necessary equipment for the unskilled workers. The amount of production would then be increased by hundreds per cent. He was of those who believed that it was quite reasonable to have a condition in which people would carry out the purely mechanical and repetition part of production, and need not necessarily regard their work as their whole life, but merely as a means of providing them with necessary bread and butter. Shorter hours, congenial conditions of labour, in so far as the sanitary and hygienic arrangements of the establishments in which they had to work were concerned, would, he believed, render those who worked under such conditions happier. That it would be necessary for them to subject themselves to a certain amount of discipline they would readily agree to when they realised the great advantage that not only they, but the community at large, would derive from this method of intensive production by means of machinery, and a very fine subdivision of work for the purpose of reducing the amount of skill necessary. The thing that was requisite at the present time was to educate the people to realise the necessity of this condition. Captain Scott-Maxwell had mentioned a system of payments by results as being the only satisfactory method of rewarding labour. While, of course, payment by results was what he were all anxious to get, yet payment of piecework was not, in his opinion, always the most satisfactory method of dealing with the worker in a modern factory producing a definite line of manufacture. It was quite possible to lay down plant and estimate with considerable accuracy the capacity of every machine in it to produce the components required; the only thing then remaining to be done was to select the operator who would run that machine at the speed and feed already decided. An individual system of piece work would not be necessary, nor indeed advisable, as what was needed was a balanced number of parts, and this result was best obtained by careful calculation of the number of pieces one could get with safety from any given machine. This method, of course, might still be considered a method of payment by results; but the great difference between this and the system of individual piecework was that, although payments were made by results, the results were predetermined, and not left to the initiative of the individual.

Mr. C. Bell-Walker said he wished to refer only to that aspect of the question bearing upon labour unrest. He was of opinion that the cause was mainly psychological, and increased pay and efficiency would not cure but might possibly aggravate it. The best work was rarely performed with the object of making money, but arose from a pride and interest in it. The danger of the Taylor system was the tendency to reduce men to the level of parts of machines. He was also of the opinion that a piecework system of payment, although at the present time the most successful and practicable, was not the system that should be aimed at because the workers' and employers' material interests were antagonistic, the formers being to do the least amount of work for the greatest amount of money, and the latters to give the least money for the greatest amount of work. It had never been proved that high wages in themselves were a cure for labour unrest.

Mr. J. A. Hannay stated that management could not be called scientific if any difference was allowed to come between capital and labour. He hoped the author was not going to make the mistake of holding out a promise of a speedy solution of the capital and labour problem by scientific management. It had taken very many years for the present difficult position to develop, and it would take a great many years to solve the difficulty. Both capital and labour would have to be patient, trust each other, and work together to bring about a satisfactory solution. Scientific management would undoubtedly play a very great part in the solution. The speaker considered that our educational means were totally inadequate, and before we could expect to get really scientific management he thought that a great many of our schools and training colleges would have to be overhauled and restaffed. Looking into the future, he considered that scientific management in the engineering industry would have to devote more and more attention to tool room, jig and tool design and equipment, and he was quite sure there should not be the slightest cause for anxiety on the part of the workmen in developing improvements to the greatest possible extent, and this would be where we should eventually find nearly all our skilled men. Some people were afraid that the workers objected to repetition work as being uninteresting; but he did not think there was anything to fear from this providing the worker was adequately recompensed and able to work under healthy conditions.

Lieut. H. Soper said practice had shown that in individual works the installation of scientific management was best carried out by starting with a small section and using that section as an object lesson to convert other sections, until the whole had been converted. In view of the distrust with which scientific management was at present viewed by uninformed persons, both employers and employed, he suggested that if the Government were to take up the work it should commence with a number of model factories, at which both employers and trade union representatives could familiarise themselves with the subject and see that there was no "string" attached to the obvious benefits offered.

Mr. N. Martin remarked that from what he had seen of the Black Country he was of opinion that a very large proportion of the workers were employed performing operations in repetition work, in which no rational human being could be permanently interested. They worked, not for the intrinsic interest of the work, but to earn their daily bread, and to do so had to be content to perform a greater or less amount of daily drudgery. If the worker was not robbed of his share, scientific or "measured" management, based as it was on ascertained fact, seemed to him to offer to the worker, without increasing the monotony of his work, a greater reward for his labour, and thus assisted him in some measure in escaping from the dreadful monotony of life that was the portion of so many workers.

Mr. W. H. Edwards said that many boys who had a technical school training found it difficult to get into large works unless they were satisfied to be dumped on a repetition machine and their efforts stultified. Manufacturers and others should offer facilities to such students,or the initiative so necessary to keep Britain in the van of the world's engineering industry would surely suffer the consequence of their indifference to the demands of futurity. He suggested the motto, "Look after your skilled men, the unskilled will look after themselves."

Street Lighting in Hackney.

There is a growing realisation of the need for a greater degree of uniformity in street lighting than we have been accustomed to in the past. It is not simply a question of using more light, although that is frequently necessary, but of distributing the available light in such a manner as to produce a higher intensity of illumination between standards than is commonly the case. In the street all light thrown out above the horizontal is, of course, completely wasted, unless some means of redirection be employed. Metal reflectors have been used in the past for this purpose, but their use has tended rather to accentuate the evil by concentrating a greater proportion of the light in the area immediately beneath the unit. What is wanted is obviously a form of equipment which will redirect most of the light at an angle slightly below the horizontal, so that with standards spaced at normal distances, the intervening areas will receive a moderate illumination.

This wide horizontal dispersion of the light is one of the main characteristics of the new street lighting system lately installed at Hackney. The installation at present consists of over 400 B.T.-H. "Efracta" lanterns, each containing a 300-watt half-watt type lamp. Ultimately there will be more than 500 of these lanterns. The B.T.-H. "Efracta" lantern was described in these columns some months ago, and is now used in combination with a special prismatic bowl refractor to redirect the light. This refractor is of clear glass, and is in two parts, one fitting inside the other. Each portion has one prismatic and one plain surface. When in position the prismatic surfaces are against one another, the inner and outer surfaces of the complete refractor thus being smooth and easily cleaned. The prisms are so arranged that all the light rays projected by the lamp into the upper hemisphere are directed downwards, whilst the downward tendency of the lower rays is slightly reduced, the result being a widely dispersed distribution with maximum intensity at 85 deg. from the vertical.

Another important characteristic of the Hackney installation is the excellent diffusion produced by the prismatic glass. The re-direction of the light is performed by the horizontal prism on the inner position of the refractor. The function of the outer glass, which has vertical prisms, is to diffuse the re-directed light uniformly over the entire area of the refractor. The proper criterion of illumination is its seeing value, and judged on this basis the Hackney installation is remarkably successful. Good diffusion, the absence of sharp contrasts, and the gradual diminution of intensity to its minimum value midway between standards, all tends to make vision easier, and generally to increase the safety of the streets.

Patents Expiring in 1920.

The following is a list of patents of interest to electrical engineers which, unless extended by the Privy Council, will expire during 1920 The list does not include any patents granted in 1906 which have since for any reason become void.

No.	Date (1906).	Name of patentee.	Subject of patent.
302	Jan. 4	Siemens Bros & Co. (Siemens-Schuckert Werke G.m.b.H., Germany)	Electricity meters.
615	Jan. 9	Borden	Telephone holders.
619	Jan. 9	Platte	Suspension of current conductors of elec. railways.
725	Jan. 10	B.T.-H. Co. & Sugden	Controlling devices for electric motors.
997	Jan. 13	Jocobs & Tnorrowgood	Telephone circuits.
1,481	Jan. 19	Bradshaw	Alternating-current motors
1,716	Jan. 23	Finlay & Finlay	Electrolytic cells.
1,924	Jan. 25	Edison	Storage battery electrode.
1,928	Jan. 25	Edison & Aylsworth	Storage battery electrodes.
1,947	Jan. 25	Highfield	Systems of direct-current supply.
2,066	Jan. 26	Berry	Insulated conductors and windings for use in transformers, dynamos, &c.
2,129	Jan. 27	Boult (Albert L. Marsh U.S.)	Resistance elements.
2,286	Jan. 30	Meiklejohn	Branch switches.
2,707	Feb. 3	Siemens Bros & Co. (Siemens-Schuckert Werk G.m.b.H., Germany)	Introduction of electrical apparatus with magnetic cores into a.c. circuits.
3.004	Feb. 7	Soc. Electrometallurgique Française	Electric mixing furnace for mixing steel.
3.127	Feb. 8	Marconi and Marconi's Wireless Telegraph Co.	Apparatus for elec. wave telegraphy.
3.213	Feb. 9	Just, Hannaman, Landesberger, Salzmann and Vereinigte Elektricitäts A.G.	Incandescing bodies for elec. lamps.
4.336	Feb. 22	Bingham	Elec. furnaces.
4,422	Feb. 23	Barr & Stroud	Electromechanical devices for producing corresponding positions in transmitting and receiving apparatus.
4,493	Feb. 23	Phœnix Dynamo Mfg. Co. and Pohl	Armature windings for commutating elec. machines.
4,926	Feb. 28	B.T.-H. Co. (G.E.Co., U.S.)	Motor-control systems.
5,136	Mar. 2	Creedy	Improvements in single-phase machines.
5,945-6-7	Mar. 12	Stratton, Claremont, Beaver and Tanner	Troughs for elec. cables.
5,957	Mar. 12	Dawson and Backham	Electromagnetic firing mechanism for guns.
6,217	Mar. 14	Poulsen	Signalling in wireless telegraphy.
6,224	Mar. 14	Hunt and Sandycroft Foundry Co.	Alternating-current machines.
6.426	Mar. 16	Hadfield	Treatment of magnetic materials.
6,454	Mar. 17	Lea	Measuring flow of gas, liquids, or mechanical and electrical quantities.
6.803	Mar. 21	Justice (Deutsche Gasgluhlicht A.G., Auerges. Germany)	Electric glow lamps.
6,939	Mar. 22	Birnbaum, White and Muller	Intercommunication telephone systems.
7.655	Mar. 30	Kuzel	Increasing the electrical resistance of metals.
7,998	Apr. 3	Fairweather (Kellogg, U.S.)	Telephone exchng. system.
8,238	Apr. 5	Beaver and Claremont	Electric cables.
8.571	Apr. 7	Salmon and Croffield	Electrical apparatus for transmitting signals.
8.401	Apr. 7	Malan	Railway switch and signal apparatus.
8.452	Apr. 9	Bailey, Plews & Anderson	Storage batteries.
8,902	Apr. 12	Dawsan and Buckham	Electrical apparatus for signalling for controlling gun fire.
9,279	Apr. 19	Johnson (Badische Anilin & Soda Fabrik, Germany)	Production of long and stable electric arcs.
9,348	Apr. 20	Dawson and Buckham	Switches for electric signalling apparatus.
9,688	Apr. 25	Brown	A.c. motors.
9,786	Apr. 28	McKenzie & Holland and Edmonds	Electrical detection between railway or tramway signals, &c.
10.457	May 4	Hopfelt	Coils for electric purposes.
10.585	May 5	Punga	A.c. motors.
11.659	May 18	B.T.-H. Co. (G.E. Co. U.S.)	Automatic controlling devices for elec. circuits.
11,974	May 22	Hadfield	Manufacture of magnetic materials.
12.001	May 23	Dugdill	Electric lamps fittings.
12.183	May 25	Gardner	System of wireless telegraphy.
12,295	May 26	Chadburn's (Ship) Telegraph Co. and Grant	Ships' mechanical telegraphic apparatus.
12,732	May 31	B.T.-H. Co. (G.E. Co., U.S.)	Machines for manufacture of incandescent lamps.
12,820	June 1	B.T.-H. Co. (G.E. Co., U.S.)	Shaft bearings for electric railway motors.
12,891	June 2	Babcock & Wilcox and Parker	Chain links of chain-grate stokers.
13.057 8-9	June 6	Shuster and Ast	Electromagnetic clutches.
13.189	June 7	Soc. Electrometallurgique Française	Manufacture of decarbonised cast iron.
13.212	June 7	A. G. Brown, Boveri & Co.	Steam turbines.
13.311	June 9	Hays (Tarner, U.S.)	Telephone dictating apparatus.
13,448	June 12	Hopkinson and Taring	Transmission dynamometers.
13.691	June 14	B.T.-H. Co. G.E. Co., U.S.)	Motor control apparatus.
13,864	June 16	Fottinger	Transmission of power.
13.903	June 18	Stevens	Working, &c., of petrol-electric cars.
14.045	June 19	Tucker	Switches.
14.089	June 19	Raven	Railway signalling apparatus.
14.253	June 21	Rees	Turbines.
14.361	June 22	B.T.-H. Co. and Dawson	Elec. distribution systems.
14.613	June 26	Warwick Machinery Co. & Samuelson	Turbines.
14.692	June 27	Ferranti	Elastic fluid motors.
14.792	June 28	Pedersen	Electromagnetic relays.
14.804	June 28	Graham	Telephone exchange switch boards.
15.256	July 5	Barr, Stroud & Jackson	Apparatus for transmitting and receiving signals.
15.444	July 7	Siegwart	Hollow masts, pipes, &c.
15.711	July 11	Hunt & Sandycroft Foundry Co.	Windings for a.c. dynamos.
16.818	July 25	Allgemeine Ges. Elektricitäts	Induction type a.c. meters.
16.820	July 25	Highfield	D.c. elec. supply systems.
17.086	July 28	Graham	Telephone transmitters.
17,225	July 31	Wilson	Price-varying mechanism for pre-payment meters.
17,668	Aug. 3	Lambert	Fittings and connections for incandescent lamps.
18.489	Aug. 17	B.T.-H. Co. (G.E. Co., U.S.)	Purifying metallic compounds.
18.599	Aug. 20	Pauling	Production of voltaic strong current arcs.
18.600	Aug. 20	Pauling	Electrodes.
18.622	Aug. 22	Justice (Deutsche Gas gluhlicht A.G., Auerges. (Germany)	Producing metallic incandescence bodies for glow lamps.
18.628	Aug. 20	Boult (Burroughs Adding Machine Co., U.S.)	Elec. driving of adding machines.
18.749	Aug. 21	B.T.-H.Co.(G.E. Co., U.S.)	Filaments.
18,842	Aug. 23	Kreen	Tramway and the like joint
18,886	Aug. 23	Joel	Electrodes for batteries.
18,944	Aug. 24	Holmgren and Brahm	Compound telephones.
18.965	Aug. 24	Graham	Telephone apparatus.
19.331	Aug. 29	Leach	Supporting device for elec. fans and fittings.
19.805	Sept. 5	Artom	Receivers for wireless telegraphy.
19.878	Sept. 6	De Forest Wireless Telegraph Synd. (De Forest, U.S.)	Signalling by electromagnetic waves.
19.881	Sept. 6	,, ,,	Wireless telegraph systems.
20,341	Sept. 13	Baxter	Blocks for use in permanent way of tramways.
21.008	Sept. 21	Giraud	Elec. igniters for engines.
21.206	Sept. 25	Venner and Griesbach	Elec. time switches.
21.290	Sept. 26	Johnson and Tetley	Insulating composition for filling conduits.
21.507	Sept. 28	Warwick Machinery Co. and Samuelson	Control of fluid supply to turbines.
21.509 and 21.513	Sept. 28	B.T.-H. Co. (G.E. Co., U.S.)	Conductors of refractory metal for use as incandescing bodies in lamps, &c.

No.	Date 1906	Name of patentee.	Subject of patent.
22,498	Oct. 11	B	Rotary condensers & condensing steam turbines.
22,519	Oct. 11	Fr	Electric transformer furnaces.
22,625	Oct. 12	B.T. H. Co. (G.E. Co., U.S.)	Dynamo-elec. machines.
22,636	Oct. 12	Belliss & Morcam & Jude..	Turbines.
22,715	Oct. 13	Dearlove and Brown	Electric condensers.
23,286	Oct. 20	Jones	Arc lamps.
23,742	Oct. 25	Varner and Griesbach	Electric time switches.
24,179	Oct. 30	Le Tell (Lederer, Austria)	Incandescent lamps.
24,582	Nov. 3	Bruce Peebles & Co. and La Cour	Phase transformers for transforming single-phas currents to polyphase or vice versa.
24,682	Nov. 3	Stratton and Claremont .	Covering for lead-covered cables.
25,087	Nov. 7	Warwick Machinery Co. (G.E. Co., U.S.)	Governing mechanism for turbines.
25,202	Nov. 8	B.T. H. Co. (G.E. Co.,U.S.)	Controllers or switches.
25,413	Nov. 10	Clarke, Chapman & Co. and Money	Arc lamps.
25,632	Nov. 13	Williams	Magneto-elec. generators.
25,753	Nov. 14	B.T.-H. Co. (G.E. Co.,U.S.)	Motor control systems.
25,978	Nov. 16	B.T.-H. Co. (G.E. Co.,U.S.)	Production of boron.
26,066	Nov. 16	B.T.-H. Co. (G.E. Co.,U.S.)	Trucks for elec. vehicles.
26,661 & 5	Nov. 23	Hadfield........................	Manufacture of magnetic materials.
26,810	Nov. 26	Warne	Conduits for cables.
26,872	Nov. 26	Graham	Telephone receivers.
26,941	Nov. 27	Meirowsky......................	Apparatus for forming insulation tubes.
26,985	Nov. 27	Siemens Bros & Co. and Ferreira	Locking frames for operating electrically controlled railway points & signals.
27,318	Nov. 30	Schaffler.........................	Apparatus for electrically firing mines.
27,725	Dec. 5	Brockie	Double carbon arc lamps with inclined carbon holders.
27,956	Dec. 7	Pedersen	Transmitting apparatus for wireless telegraphy.
28,306	Dec. 12	Maley	Brakes for rolling stock.
28,319	Dec. 12	Strecker-Aufermann	Electrolytic etching of printing plates.
28,562	Dec. 14	Fried. Krupp A.G.	Automatic starters for c.c. motors.
28,602	Dec. 14	Poulsen	Wireless telegraphy.
28,714	Dec. 15	Parsons and Short	Machines for shaping turbine blades.
28,830	Dec. 18	Haywood & McKenzie and Holland	Electric treadles or rail deflection contact makers.
29,050	Dec. 20	Bellamy	Ignition device for engines.
29,072	Dec. 20	Brown	Elec. railway & like signals.
29,153	Dec. 21	Mallins	Rail-sanding apparatus.
29,450	Dec. 27	Barr & Stroud	Apparatus for transmitting and receiving signals.

Correspondence.

PROF. ARNOLD'S NEW HIGH-SPEED STEEL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The claim put forward by Dr. Arnold of having discovered a new high-speed steel in which no tungsten is used, and the resulting discussion in the Press, has created widespread interest in metallurgical and engineering circles. As we have been manufacturing tungstenless molybdenum high-speed steels for some considerable time, and have given very great attention to the theory and practice of alloy steels generally, perhaps you will permit us to give the public some important facts relating to the matter which have not been brought to light.

We may say at the outset that we fully endorse Dr. Arnold's view that molybdenum in high-speed steel produces far better results than tungsten. We must, however, dispute his claim that his formula is new, and also that vanadium has proved an efficient stabiliser of molybdenum when used with it. As a matter of fact, not long after the introduction of tungsten high-speed steel, molybdenum high-speed steel, both with and without vanadium, was made in the United Kingdom, France, Germany, Luxemburg, Austria and the United States similar to the formula which Dr. Arnold has now made public. The occasional startling results of such molybdenum mixtures, superior to the very best tungsten high-speed steel, induced many firms to plunge into schemes for producing molybdenum steels on an extensive scale; but all had to be abandoned because the resulting product lacked uniformity. Much of it was of excellent quality; but, on the other hand, batches of tools failed entirely when subjected to workshop tests, although they showed the correct analysis. In the cases where vanadium was added it failed to be uniform in bulk manufacture, just the same as the molybdenum steel without vanadium; consequently the makers fell back upon tungsten.

We attribute Dr. Arnold's erroneous faith in vanadium as a stabiliser to molybdenum steel to the circumstance that he experimented merely on small quantities. However, only bulk production can disclose the presence or otherwise of a real stabilising element. Mr. P. R. Kuehnrich, of Sheffield, made the discovery that cobalt acted as a definite stabiliser to molybdenum, and he patented a formula to this effect. As the licensees under that patent, we have made and distributed hundreds of tons of the "Como" brand molybdenum super high-speed steel, and completely proved that cobalt is *de facto* a stabiliser. "Como" steel is now largely used in many parts of the world, and is thoroughly justifying the warranty advertised in the technical press guaranteeing it to produce superior results to tungsten high-speed steel.

The molybdenum high-speed steel is more costly to produce than tungsten steels; users, however, are only too willing to pay the higher price, as the greater service the material renders makes it intrinsically the cheaper material.—We are, &c.,

DARWIN & MILNER, LTD.
SYBRY, SEARLS & CO., LTD.
SPARTAN STEEL CO., LTD.

Sheffield,
Dec. 24.

THE ELECTRICITY (SUPPLY) BILL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been drawn to your Leading Article in your issue of the 19th instant with reference to the Electricity Bill. I notice that you state that the only memorandum of views actually sent to the House of Lords emanated from the Chairman of the Provincial Electric Supply Committee. I am authorised to say that the statement upon which the financial argument of Lord Downham and Lord Moulton was founded was prepared for the former by his usual professional advisers, and was subsequently submitted to Lord Moulton, and neither Mr. Renwick nor the Committee of the Provincial Companies were consulted in the matter.

I would ask you, therefore, if you will kindly correct the above statement, as credit ought to be given where it is due.—I am, &c.,

W. A. PEARMAN,
Secretary, Westminster Electricity Supply Corporation.

London, Dec. 24.

MERCURY RECTIFIER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Mr. Sayers' letter this week on p. 731, the "Electric Railway Journal," Vol. XLIV., p. 1343, 1915, gives a report upon the 11,000 volt high-power rectifier. Other reports upon such mercury arc rectifiers using steel containers for the arc will be found in the "Electrical Review," Vol. LXXXIV., p. 191, 1919; the ELECTRICIAN, Vol. LXXXII., p. 589, 1919; the "Electrical World," Vol. LXII., p. 518, 1913, and Vol. LX., p. 1157, 1912. Also in the "Elektrotechnische Zeitschrift," Vol. LXXXIII., p. 1164, 1919, Vol. XXXIV., p. 253, 1415, 1479, 1913, Vol. XXXVIII., p. 88, 1917, Vol. XXXIX., pp. 321 and 414, 1918.—I am, &c.,

London, Dec. 20. ALEX. B. EASON.

The Electrician.

FRIDAY JANUARY 2nd, 1920.

Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.

Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

1919.

The usual journalistic custom of devoting the Leading Article in the first issue of a New Year to the events of the preceding year must, on this occasion, be modified, for what we really have to consider are the events which have taken place since the signing of the Armistice on November 11 1918.

INDUSTRIAL CONDITIONS.

The period under review has been a testing time for the British engineering industry, and despite the many apparent failures, so loudly deplored and condemned, both upon the platform and within the columns of the Press, it has withstood the test. Our optimists and our pessimists have both, to a large extent, proved wrong in their prognostications; the former in their prediction of an easy and speedy transition from war to peace conditions, and the latter in their gloomy forebodings that the workers would effectively stifle the industry of the country.

If we have no cause for jubilation at least we have no cause for depression, and we can feel a deep sense of quiet satisfaction. Despite the abnormal conditions which are still prevailing—such as high prices, the acute housing shortage, the vast army of unemployed, and the many labour troubles—each of which has an adverse effect upon the engineering industry, the fact remains that, as a whole, we are in a much stronger position than we were just prior to August, 1914: and this, we think, is because at last the industry recognises its responsibilities.

In changing from peace to war we were faced with as difficult a problem as in changing from war to peace. To pick up the ends where we dropped them in 1914 was not an easy matter, for conditions had entirely changed. Factories were under Government control, and reorganisation and reconstruction were necessary before they could again embark upon their commercial duties. The heads of great concerns, released from the thraldom of four years of war-time concentration, were for a time bewildered, and unable to reconstruct or to reorganise. For four years they had done just what they were told to do: their business instincts, their initiative, and their commercial sagacity had been stifled, and when they were at last thrown upon their own resources they were confronted with a task which seemed quite beyond them. But looking at Germany, Austria, France and Belgium, we saw that they were in an even worse plight, while the activities of America and Japan—the countries which had gained materially as a result of the war—showed that we should have to work for our commercial existence. So we shook off our stupor, and the position in which we stand to-day shows that our efforts have not been in vain. Despite the pessimists, and all they say to the contrary, we have actually gained ground. We have discovered, among other things, the real meaning of reconstruction, and we have found out that we can reorganise. We know that more production is necessary, and that wages are high; and we know also that good management, applied to every phase of the factory system will give the desired results.

During the year Labour has been in a most unsettled condition, but this is a natural sequence of abnormal conditions, and while this unrest is to be deplored, on the other hand it may be instrumental, not in stifling industry but in expanding it. Reconstruction, to be effective, must eliminate the old order of things, and substitute something quite in keeping with the times. The worker expects to benefit like any other member of society. For him the old order of things is intolerable. He cannot be blamed for preferring to live rather than to exist, and we know now that a properly organised industry will enable him to live—and his employer also. The only thing that he must do is to give value for money, and there is every hope that he will do that.

It is certain that we can increase production; we can improve quality; we can afford to pay good wages; and we can secure adequate profits. We can do all these things, and sooner or later we shall do them, and it is only diversity of opinion which is retarding that happy consummation. We are all thinkers, and being thinkers we know we must be workers. Our modes of procedure, however, have not yet been co-ordinated, and each endeavours to approach the ideal by a different process. For whilst it must be admitted that the war has brought out much that is base in our natures, it cannot be said that we are altogether to blame. We have for some time been accustomed to think in millions, and to talk in millions, and we cannot be expected to revert to the principle of pounds shillings and pence without a struggle. The thousands of the rich, what are they, compared with the pre-war standard? The dividends—20, 30, 40 per cent. What does it represent nowadays? The workers' £4, £5? It may sound a great deal after the 30s. and £2 of 1914, but what is it worth to-day?

Prices will have to come down, although the process may be slow. This also is a fundamental part of the scheme of reconstruction. We are going the right way to work, and our reorganisation is in accordance with our own peculiar requirements. We know what America is doing, and realise the important part organisation plays in that country. America has taught us a lesson in this respect, but knowing that she organises to meet the prevailing conditions, we profit whilst we do not copy. The principle of organisation is the same all the world over, but its adoption must be governed by conditions—temperamental, climatic, geographical. Recent events have taught us that we must produce to sell; that the engineering factory is a commercial proposition, as well as a constructional emporium. This is a lesson well learnt which we must seek to profit by in future.

THE ELECTRICAL INDUSTRY.

The change over from war to peace time conditions has been accomplished successfully, and during the past year the electrical industry has been gradually finding its feet. Progress has, however, been hindered by a succession of unfortunate strikes and by general labour disorganisation. In the early part of the year there were sectional railway strikes in London and in other parts of the country, while in September the disastrous general railway strike emphasised the important part which communications now play in the life of the country. But it may be said that the only bright spot in this particular upset was the way in which motor vehicles, both petrol and electric, were able to deal, at least temporarily, with the situation. During the past three months the ironmoulders have been on strike, and it is unnecessary to emphasise here the retarding effect that this has had, and is having, on the production of all kinds of electrical apparatus. We hope it will not be long before a satisfactory agreement is reached and that the work of producing castings, which are so essential in all forms of engineering, will go forward once more with increased vigour.

Coal Supply.

The coal question has been a vital one during the year. Fortunately, the coal strike, which was several times threatened, did not actually come about, but the constant interference with the price and supply of coal by the Government, and the general unrest on the part of the miners, caused by the vacillating attitude of the authorities towards nationalisation, have had the effect of introducing a feeling of uncertainty into all branches of industry. The electrical industry depends, perhaps more directly than many others, on an adequate supply of cheap fuel, and it has suffered accordingly; while the introduction of various rules and regulations dealing with the use of this commodity, and culminating in the reduction in price of 10s. per ton on all coal supplied for domestic purposes has had a most unsettling effect. If industry is to be controlled at all it is of the highest importance that some definite policy should be laid down and maintained. There is a great deal to be said for strong autocracy, but a weak autocracy can only lead to revolution. For the moment the idea of limiting profits in the coal industry seems to have been dropped, and we hope that this is an omen that control, or rather interference, by Government departments in this vital form of industry is shortly to be done away with. It can only lead to disaster.

Electricity Supply.

Electricity supply has developed during the year on satisfactory lines. There has been an increasing demand for energy for power purposes, which, unfortunately, has not always been able to be met in full, owing to the delay in delivering the necessary generating plant needed for extensions. Electric lighting has also made satisfactory progress, and in connection with many of the new housing schemes, in various parts of the country, it has been definitely decided that electric lighting shall be used, and in some cases electricity for other domestic purposes will also be employed. It is, however, necessary, if electric lighting is to have its full developments, that the cost of wiring should be reduced to a minimum. This is more important even than reducing the price of energy supplied. Perhaps the most definite progress in this section of electrical activities has been in heating and cooking where saturation point has not been so nearly reached as in the other branches. In another column of this issue we give a more detailed account of what has been done in this way during the year. The year has seen no great novelty introduced either in lighting or in power plant, but at the same time quite definite progress has been made, and we hope that during the coming months this will be continued, especially in the provision of the most necessary shades and reflectors for use with gas-filled lamps. This is a necessity if the public eyesight is not to suffer, and if as a result there is not to be a definite reaction against the use of this class of apparatus. With the introduction and greater use of high candle-power gas-filled lamps it is interesting to note the gradual disappearance of the arc lamp. This is, perhaps, regrettable for sentimental reasons, as electric light was first produced in this form. In a general way the whole supply situation has been overshadowed by the Electricity (Supply) Act, which received Royal Assent a few days ago.

Propaganda.

We have always felt that in order that the benefits of the use of electricity might be brought to the notice of as large a number of inhabitants in this country as possible, it was necessary that some definite scheme of propaganda should be adopted and used for all it is worth. The formation of an Association for this purpose, known as the Electrical Development Association, is, therefore, an interesting landmark in electrical progress. This Association is managed by a committee, and has, during the past year been able to make substantial headway. Not a little of the success is due to the Director, Mr. J. W. Beauchamp, who, as pointed out in a recent issue, has taken up the subject very seriously with most satisfactory results.

Electric Traction.

The question of the adoption of electric traction has recently been receiving a large amount of consideration by many of the railway companies of this country. This change in their ordinary methods of working has become, to some extent, compulsory. The volume of passenger traffic, especially in the neighbourhood of large cities, is growing to such an extent that the present methods of dealing with it are becoming rapidly inadequate, and the railway authorities are, therefore, faced with large and costly schemes of reconstruction, or as an alternative the adoption of electric traction. More will be heard of these schemes during the coming months, and we hope that as a result some alleviation of the sufferings of suburban passengers will shortly be the result. Those railways which have adopted electric traction have had no reason to regret their enterprise, so far as the engineering side of the question is concerned; but the increased and more convenient service, which was the immediate result of the conversion, has led in some cases to such a large increase in traffic that the department concerned with handling that branch of railway organisation has been nearly overwhelmed. The most interesting feature during the year in this branch of electrical activity is the decision of the North-Eastern Railway Company to introduce electric traction on their main line between York and Newcastle. Far-reaching schemes in other countries, notably India and South Africa, are also under consideration. As regards tramways, during the past year, there has been little progress and the question has arisen in an urgent form as to how far tramways should be extended or whether their place should be taken by the motor omnibus. This question has, however, not been decided, and we hardly think that it can be decided in so general a form. More will doubtless be heard of it during the coming year, and we shall await the outcome of discussions with considerable interest. At the moment we see no reason to consider the tramway as a " back number," though we think the problems of its development will require the most careful consideration.

The Electricity Supply Act.

The Bill was introduced for first reading on May 8, 1919, and in due course Sir John Snell's name was announced as Chief Commissioner designate. The Bill passed into the hands of Grand Committee on July 9, 1919, and after 19 meetings was duly handed back to the Commons on Report Stage. In due course it went to the House of Lords, and there entered on what was a particularly dramatic phase of its career. The Government did not anticipate that the House of Lords would put up any fight, and the Lord Chancellor, who was in charge of the Bill, was obviously taken by surprise. The debate was adjourned and when it came on again in a few days the criticisms were renewed, and there were hints of relegating the matter to a

Select Committee. But between the time of the House rising on December 3rd and when the Bill was again taken (December 8th) the Government had evidently been occupied in taking stock of the opposing forces. For when the Order Papers for the House of Lords came out on the Monday there was evidence of a dramatic change of policy; in fact, an entire revolution of the administrative machinery provided by the Bill. The District Boards were entirely done away with, and with them, of course, went the compulsory expropriation of the generating stations of the country. That this was a very late and reluctant concession from the Government might be deduced from the fact that, out of the 19 days spent by the Grand Committee on the Bill, over half of least were spent on clauses relating to the District Boards or compulsory purchase, all of which, and perhaps even further time, could have been saved had the Government not insisted that District Boards were absolutely necessary to the scheme. The Bill received the Royal assent on December 23rd, and in the King's speech he said that it was greatly hoped that upon the reassembly of Parliament consideration of the remaining portion of the Electricity Bill would be resumed. The general undertaking to bring in another Bill to deal with this question of District Boards, although it need not be taken too seriously, certainly behoves the electrical undertakings to retain their forces in the field.

On the engineering side, the events of the year have been the putting to work of a new station at Rotherham, the starting up of a 25,000 kw. turbo-generator at Manchester, and the arrangements made for the linking up of various undertakings in South-east Lancashire.

OBITUARY.

As years go on we have to mourn from time to time the departure of the pioneers of electrical science in industry. During 1919 these losses have been particularly heavy. They include Lord RAYLEIGH, Sir WILLIAM CROOKES, Prof. G. CAREY FOSTER, H. ARMAGNAT, E. CUNLIFFE-OWEN, DEVAUX-CHARBONNEL, Prof. A. G. V. HARCOURT, A. C. REYROLLE, S. SELLON, C. H. STEARN, A. J. WALTER, Prof. W. WATSON and Dr. HENRY WILDE.

Non-Ferrous Mining Committee.

This committee, which was appointed by the Board of Trade to inquire into non-ferrous mining, has adjourned until Jan. 5 after having examined a number of witnesses on lead and zinc mining.

Mines in the Halkyn district of Flintshire were represented by Mr. Noel Humphreys, Mr. Walter Conway and Mr. J. L. Francis, who stated that the mines in the district were now worked down to, or below, the level of the existing drainage tunnel. They were of opinion that the completion of the new sea-level tunnel was essential, and that State aid could usefully be given to that end. They favoured pumping at the North Hendre, Llynypandy and South Halkyn mines. Mr. Philip Jones, manager of the Holywell Halkyn Mining & Tunnel Company, thought that the Government could most effectually help the district by proceeding with the Mid-Flintshire Light Railway scheme, by providing cheap electric power from a central station at Queensferry, and by guaranteeing minimum prices for galena and blende. Mr. T. Miller, manager of the Welsh Van mine, advocated a Department of Mines, the revision of mining and mineral laws, and the establishment by the Government of a customs works to smelt home-produced ores. Mr. R. R. Nancarrow, manager of the Lisburne Development Syndicate, suggested that State aid (for five years) should take the form of a bonus of 7s. 6d. a foot on all approved development work and of a minimum price for the products got in relation to the increase in mining costs since 1914; while Mr. Horace Boot, who represented the mines of the Conway Valley, was of opinion that help should be given to the industry by the guarantee of a market for blende at a reasonable price, by an amendment of the system of royalties, and by the establishment of a Department of Mines to investigate and remedy the troubles of the mine owners.

At the last sitting Prof. O. T. James, of the University of Manchester, gave the results of investigations recently undertaken for the geological survey in the mining district of Cardiganshire and West Montgomeryshire. He expressed the view that new ore bodies could only be opened up in the district by extensive prospecting and development.

A Scottish Hydro-Electric Scheme.

An elaborate report on the proposed Tummel water-power scheme has been prepared for Dundee Corporation by Messrs. Meik & Buchanan and Sir Alex. Binnie, Son & Deacon. The scheme includes the development of Lochs Ericht, Laidon, Rannoch and Tummel. The average flow of the River Ericht, including the Allt Ghlas stream, which would be diverted into the loch, would be 15,500 cubic ft. per minute. A reservoir capable of storing 100 days of that flow and other works would have to be constructed. Assuming that sufficient plant is provided in the power house on Loch Rannoch shore, the power developed from Loch Ericht would meet a maximum load of 16,200 kw. throughout an average year at the Dundee transformer station, the average continuous load being 5,670 kw.

In regard to Loch Rannoch, the second instalment of the scheme, it is calculated, after the construction of a dam and other works, that from the power house, which would be below Tummel Bridge, plant would be erected to meet a maximum load of 23,000 kw. at Dundee, the average continuous load being 8,050 kw.

As to the Loch Tummel scheme, any work which impounds the water of this loch would flood a large area of land, but there are several sites where dams could be constructed near the outlet. The pressure tunnel proposed would be 3 miles, terminating in a surge shaft, from which steel pipes would convey the water to a power house on the Garry. Calculating an average run-off of about 5,000 cubic ft. per minute, and adding the 65,000 cubic ft. per minute from No. 2 power house, the average run-off would be 70,500 cubic ft. per minute. The Tummel Falls would, however, be spoilt for tourists.

Regarding the transmission line, it is calculated that the distance from the power house on Loch Rannoch to Dundee will be about 65 miles. Three-phase current would be transmitted at an initial voltage of about 75,000. The total power available at Dundee would be as follows:—

	Average kw.	Maximum kw.	No. of units annually.
Loch Ericht	5,670	16,200	48,460,000
Loch Rannoch	8,050	23,000	70,500,000
Loch Tummel	8,050	23,000	70,500,000
Total	21,770	62,200	189,460,000

On the basis of double pre-war prices, it is calculated that the Loch Ericht portion of the scheme would cost £700,000, exclusive of land and transmission wires; and as the maximum load which could be met would amount to 16,200 kw. throughout an average year, this portion of the scheme would comply most economically with the requirements for the first instalment. In a year of extreme drought, the maximum load which could be always maintained would amount to 13,500 kw., representing a sale of 41 million units annually. In an average year the load would represent a sale of 50 million units.

FINANCIAL.

It is assumed that the Corporation intend to put before Parliament a complete scheme, to be developed in stages, and the first instalment would be debited with the expense necessary to purchase land, &c. The gross cost of the first instalment, allowing 15 per cent. for contingencies, and including transmission line to Dundee, works out at £1,134,000. Assuming that the Corporation would get powers to pay interest out of capital during construction (three years), the total capital cost would be £1,217,000. Capital charges and working expenses are put at £95,400, and the cost per unit delivered at Dundee (48,460,000 units) at 0·472d. The second instalment (Loch Rannoch) is estimated to cost £1,903,000, with annual capital and working charges at £135,900. The cost per unit on a basis of 70,500,000 units is 0·463d. The two schemes combined would cost £3,120,600, with £231,300 for capital charges and working expenses, giving a total of 118,960,000 units at a selling price of 0·467d. per unit.

The third instalment (Loch Tummel) is estimated to cost £1,520,000, with £117,600 as capital charges and working expenses, giving a total of 70,500,000 units at 9·4d. per unit. The complete scheme would cost £4,640,000, the total annual charges being £348,900, and giving 189,460,000 units at 0·442d.

The principal landowners have apparently a strong feeling that power should be available for use in the Tay Valley, and strong opposition is to be anticipated to any scheme which involves taking away the whole of the power without giving a right of participation to those who inhabit the valley.

Commenting on the joint report Mr. RICHARDSON, the city electrical engineer of Dundee, states that comparisons between steam plant and water-power might lead to the conclusion that there is not sufficient probable saving to decide in favour of using the water-power, but there were many other factors to be considered, among them being the increasing costs of coal, plant, transport and higher salaries and wages. If the first instalment were completed, the possibility of extension up to the likely requirements of Dundee would be assured for many years to come, whereas it appears doubtful whether the Harbour trustees are going to grant facilities for the projected extensions of the present Carolina Port station. Mr. Richardson thinks the Corporation should come to an early decision as to what form the extensions should take, because deliveries of plant, building, &c., are so delayed at the present time that orders should be placed early if the demand for electric current is to be met.

Whitley Councils.

On the 22nd ult. a conference of representatives of the electricity undertakings in the greater London area was held for the purpose of forming a District Council. The meeting was called by the National Joint Industrial Council of the Electrical Industry, and representatives were present from the company and municipal electricity undertakings as well as representatives of the different unions concerned. The chairman (Mr. C. P. Sparks) explained that the District Council would take the place of a joint committee that had been in existence for 18 manths in the electrical industry in London, and which had done good work. It would secure joint action between employers and workpeople for safeguarding the industry, and for the general improvement of conditions with a view to the best interests of all employers and workers. There would be an equal number of representatives of Labour and of the employers. They would have had a very difficult time in the industry if it had not been for the action of four unions on the one side, and a number of employers on the other, in forming a joint committee.

After some discussion on the constitution and numbers of the proposed district councils and the unions to be represented, a resolution was unanimously carried that a district council should be set up for the Greater London areas. It was agreed that separate meetings should be held in order to elect the representatives of the employers and workers respectively, and that a joint meeting should be called again as soon as possible.

The Osram Lamp.

One of the most certain things about modern trade is that it does not matter how good an article is if the public is not kept constantly aware of its goodness. If this is done, and the article is worthy of merit, its success is then assured. This dictum may be well applied to Osram lamps, and the latest attractive pamphlet dealing with them which has been designed by Mr. H. Clifford Palmer, the manager of the Publication Department of the General Electric Company, should lead to a still greater demand for this useful electrical apparatus. The pamphlet, the outer cover of which we illustrate, gives full details including prices of various types of Osram lamps now on the market, both the vacuum and gas-filled types being dealt with. This artistic production, which has also been arranged as a show card, is well worthy the notice of electrical contractors and other large sellers of lamps.

Tin mining is one of the most important industries of Bolivia and the value of the exports of tin ore in 1918 was £10,370,500, compared with £6,820,280 in 1917. Progress was retarded by lack of shipping and of mining machinery, &c. The principal markets for Bolivian tin were Great Britain, which took 56 per cent., and the United States 37 per cent. of the output. Since June considerable American interest has been displayed in the Bolivian tin mines and the capacity of the new American smelters is said to require even more of the Bolivian output if it can be secured. The Canadian Government also have had a representative at La Paz inquiring into the prospects of contracting for the output of one or more mines to go to the Dominion of Canada for smelting by a new electric process.

The Gattie Transport Scheme.

The Departmental Committee appointed to investigate Mr. A. W. Gattie's proposals for improving the method of handling goods and traffic, and to consider the practicability of introducing any of the suggested improvements into the existing transport system, have issued their report and declared against a central clearing house for London. Among the objections urged are :—

(*a*) The huge capital expenditure required ; (*b*) the displacement of a large population ; (*c*) the impracticability of the large volume of traffic involved being conveyed over the railway lines connecting the trunk systems and the clearing house ; (*d*) the concentration of the whole of the goods traffic at one spot, which would mean that all street traffic would converge on that area ; (*e*) the necessity of maintaining most of the existing depots, as coal and mineral traffic could not pass to the clearing house ; (*f*) the complete upheaval of all the practices and customs of the carrying on of public trade which would result from the establishment of the proposed clearing house apart from its effects on railway working throughout the country ; (*g*) the fact that the proposed method of dealing with goods for sorting would increase the amount of handling.

The Committee point out that Mr. Gattie was very emphatic in stating that he was desirous of his scheme being adopted in its entirety, and he did not want the Committee to recommend the use of one portion of the system to the exclusion of another. The Committee consider this opinion to be founded on a correct appreciation of the necessity for co-ordination of all the traffic if the clearing-house system in large centres should be found suitable for adoption. If the Gattie scheme were adpoted it must be applied to every town in the country, and machinery for handling the containers would have to be provided at every goods station remaining in operation. No detailed estimate had been made of the cost of this, but Mr. Gattie suggested that at pre-war figures it might cost £300,000,000. At present-day costs the outlay would be much greater and the Committee cannot recommend such an expenditure. The estimate of the promoters that over 80 per cent. of the total locomotive haulage power in the country was wasted in shunting was not justified by the facts, and the Committee think that the extra tare weight of the containers would add to the haulage costs. The Committee are unanimous in their opinion that a concentration over so large an area as that proposed for the metropolis would be physically impossible and economically wasteful. The centralisation of the whole traffic now carried on by the 74 goods stations in one concentrated clearing house at Clerkenwell or elsewhere in the centre of London would produce so much congestion at the centre and everywhere near the centre as would make such concentration impossible in practice. The estimate of £26,000,000 for the whole of the clearing house and its machinery and rail and road connection appeared to be far too low.

London Traffic Finance.

At a sitting of the ADVISORY COMMITTEE ON LONDON TRAFFIC last week, Sir Harry Haward, Controller of the London County Council, stated that the total capital expenditure of the tramways undertaking up to March 31 last was £13,693,752. The debt incurred, including stock issue expenses, was £14,022,835, of which £5,552,801 had been provided for, leaving a net debt of £8,470,034. The capital commitments amounted to £1,950,000, and should additional powers be granted that figure would be increased by £1,000,000. The deficiency on the working of the tramways was at present £137,000 per annum, and it was anticipated that next year it would be £580,000. That result had been brought about by great increases in working expenses, particularly in wages. Suggested relief could only be obtained by means of legislation in regard to the rating of tracks, road maintenance, &c. He did not consider that the debt charges constituted an unusual burden, and it would be possible instead of repayment by equal instalments to set up an annuity on the cumulative sinking fund principle. That would save over £100,000 a year. The capital commitments at present were in the neighbourhood of £2,000,000, and he believed that the revenue could not meet that figure.

Mr. KENNEDY JONES : You do not see any way open except by an increase of revenue ?— Not necessarily. If there were less competition with motor-'buses we could probably meet the expenses on the present fares.

Sir ALBERT STANLEY, on behalf of the Traffic Combine, said that, excluding the amount of the subsidy of £560,000 which the District Railway, a controlled line, received from the Government, and approximately a reasonable sum as allowed for renewals, the operating results from all the ten companies for the current year would show a loss of £600,000. That was without making provision for fixed charges and interest upon any of the guaranteed stocks which might be outstanding or for interest on preference and ordinary shares. It was estimated that the loss in the year 1920 would be £2,600,000. The total expenditure for 1920 over that of 1919 would be £2,650,000, and that sum would have to be raised in increased earnings. There was not the remotest chance of meeting the loss except by an increase of fares. The services carried 1,300,000,000 passengers in the year, and an addition of a halfpenny on each passenger for each journey would realise £2,500,000 yearly. With regard to the future of omnibuses, the new type of vehicle would, of course, have an increased earning capacity and petrol would be cheaper, but the 'buses were more expensive.

Legal Intelligence.

Workmen's Compensation.

In the City of London Court last week the widow of a cable jointer, named Farrant, was awarded £300 as compensation for the death of her husband, who was killed in a h.t. switch room of the County of London Electric Supply Company. The company urged that Farrant ought not to have gone into the switch room until he had ascertained that the power had been turned off, and therefore that there was no liability on it to pay compensation. The Deputy Judge (Sir John Paget, K.C.) found for plaintiff, holding that defendant company had failed in its duty in regard to fencing or enclosing the switchboards.

Electrodes Patent.

In the Commercial Court on the 18th ult., Mr. Justice Roche gave judgment in the action brought by Mr. T. Scott Anderson, against Clayton & Shuttleworth, Limited, for the recovery of £750, the price (100,000 ft. of electrodes), or in the alternative damages for alleged breach of contract to take and pay for the goods. The claim was admitted, and defendants counter-claimed to recover the same sum as damages for alleged breach of warranty. The case for the defence was that plaintiff warranted that the electrodes were not an infringement of any person's patent, and that he had a right to sell them, and it was alleged that the electrodes were an infringement of letters patent granted to the Quasi Arc Company. Plaintiff's reply was that the electrodes were not an infringement, being covered with blue asbestos fibre and not blue asbestos yarn.

Evidence was given on behalf of the Quasi Arc Company that they were not prepared to grant a licence to the defendants to use the electrodes.

Giving judgment, Mr. Justice Roche said the real question was the question of defendants counter claim when the goods were agreed to be bought and sold. He held that plaintiff, in making those electrodes was infringing the patent of the Quasi Arc Company. He was satisfied that owing to a change in defendants' business the goods had become of much less value to them than the £750, which they had agreed to pay. He held the value of the goods would not have amounted to more than £500 at the material times. He gave judgment for plaintiff for £750 on the claim, and judgment for defendants for £500 on the counter claim, and there would be a set off and the balance paid.

Institution Notes.

The Bureau of Standards (Washington, D.C.) has issued Technologic Paper No. 139, on "Some Tests of Light Aluminium Casting Alloys; the Effect of Heat-Treatment." The mechanical properties of a number of different compositions of cast light aluminium alloys have been determined as well as the resistance to the action of alternating stresses of three commonly used alloys. The effect of heat treatment of cast alloys, consisting of annealing at 500° C. and cooling in air from that temperature, followed by ageing for several days before testing, produced an increase in the tensile strength and hardness, with an attendant decrease, usually in the elongation.

At the December meeting of the Diesel Engine Users' Association Mr. Chas. Gould, electrical engineer to the first Garden City, Letchworth, was elected President for the ensuing year, and Mr. Percy Still, chief engineer and manager to the Chelsea Electricity Supply Company, was re-elected honorary secretary. Messrs. Geoffrey Porter and A. W. A. Chivers were elected members of the General Committee in place of the two members who retire at the end of their term of office. The present members of the Standing Committee on Insurance were all re-elected. The Honorary Secretary made his annual statement, referring to the further growth in the membership of the Association, &c. Under the present rules membership is extended to users of semi-Diesel engines. Certain definitions of Diesel and semi-Diesel engines had been discussed and formally adopted by the Association. During the year some cases of breakdowns occurring on Diesel engines had been fully discussed and much useful information had been obtained and circulated among the members. Besides the reading of several interesting Papers, other work carried out by the Association included the hearing and settlement of a dispute between the parties interested in the standard Policy of Insurance against Breakdown at Lloyds, successful representation to the Coal Controller that electricity supply undertakings using oil as fuel should not be subjected to the restrictions imposed by the Household Fuel and Lighting Order. The Committee of the Association made comments and offered suggestions to the British Engineering Standards Association in connection with a proposed standard specification for Diesel engines for electrical plant, and the latest action taken by the Association was in connection with the formation of a Research Association for Liquid Fuels. The first members of a Provisional Committee for a Research Association for Liquid Fuels have been appointed.

Considerable extensions of the electric supply works in the Province of Limburg (Belgium) are projected, and the expenditure involved is estimated at 12 million francs. It is proposed to form a joint stock company which will undertake all responsibility in relation to the Government for the financial and technical execution of the scheme.

Commercial Topics.

British Goods for Canada.

According to a recent communication from H.M. Trade Commissioner at Toronto, there is a substantial demand for British goods, and that he has received a number of inquiries concerning them. Considerable disappointment is expressed by local buyers as to the comparatively slow return of the United Kingdom manufacturer to this market. Many of the quotations received are too high and statements with regard to delivery are very indefinite.

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London Electricity Supply Loans.

During the financial year 1918-19 the London County Council sanctioned the borrowing of £279,059 by London Borough Councils for electricity supply purposes compared with 21,582 in the previous year, and £93,622 in 1916-17. With the exception of the year 1913-14, when loans amounting to £291,672 were sanctioned, the sum borrowed was higher than in any year since 1905-6, the culmination of the high-water mark period of electricity supply expansion in London. Since 1889-90 the London County Council have sanctioned 562 loans, representing £7,084,736, for electricity supply in their area. A large part of this sum has already been repaid, but the figures will give some idea of the importance of the municipal electric supply in London and of the capital expended upon the industry.

* * * *

The Coal Rebate and Electricity Consumers.

A committee, consisting of Mr. Roger T. Smith, president of the Institution of Electrical Engineers (chairman), and representatives of the Incorporated Municipal Electrical Association, the Incorporated Association of Electric Power Companies, the Conference of Chief Officials of London Electric Supply Companies, and the Provincial Electric Supply Committee of the United Kingdom, has had several interviews with the Coal Controller, and has drawn up a memorandum to show how the reduction to be made to electricity consumers to correspond with the 10s. reduction in the price of coal is to be carried out. The memorandum will be distributed to the various electricity supply undertakings.

* * * *

The Brussels International Fair.

This Fair, which will be held in Brussels from April 4 to 21, 1920, promises to be of unusual importance to British manufacturers. It is being organised by the municipality with the financial support of the Belgian Government and the Province of Brabant. Exhibits will be divided into 29 groups and there will be important displays of electrical machinery, fittings, cables, telegraphs and telephones, &c. The Palais Midi will be reserved for the exhibition of large machinery requiring motive power, but the largest portion of the exhibition will be in the Parc Royal, comprising 1,400 stands, in addition to an open-air space for agricultural machinery. Stands may be rented whole or in part. Applications for space and further information should be made to the Executive Committee of the Fair, Grand Place 19, Brussels, by Jan. 15.

* * * *

Wiring of New Houses.

We are pleased to notice that in connection with the housing scheme of Wolverhampton Corporation an arrangement has been made for the electric lighting of the houses. It is proposed to charge a uniform rate of 1s. per week or thereabouts, according to the number of lights, which will be collected with the rent, thus obviating the cost of meters, inspection, reading and separate collection. The houses will be fitted with a current limiter, which will prevent more than 75 per cent. of the lights being used simultaneously. No doubt this method will be an advantage to all concerned, but in order to protect the fittings from damage it is proposed to require the payment of a deposit by an incoming tenant, and the tenant must replace damaged or broken fittings. The deposit will be returned to the tenant on leaving the house, subject to a reduction for any damage or breakages. We hope that all local authorities with electric supply undertakings will take similar steps to ensure that the new houses in their areas are wired.

* * * *

Railway Rates Increase.

The considerable increase of freight charges which is announced by the railway administration will have a serious effect upon the trade and commerce of the country at a critical time. The revised charges will come into force on the 15th inst., and are due to the increased expenditure of the railways owing to the higher wages and the enhanced cost of materials, &c. The new rates show increases varying from 25 per cent. to 100 per cent., with in many cases the addition of a flat rate of from 3d. to 6d. per ton, irrespective of distance. The 100 per cent. increase applies to small parcels and to certain "empties." The charges for coal, coke and patent fuel are increased by 25 per cent. and a flat rate addition of 3d. per ton. Other merchandise in class A of the General Railway Classification is increased by 30 per cent., and in class B by 50 per cent., with a flat rate addition of 3d. per ton. Merchandise in class C is increased by 50 per cent., with a flat rate addition of 6d. per ton; while merchandise in classes 1 to 5 of the general railway classification is increased by 60 per cent., with a flat rate of 1s. per ton. Rolling stock is increased by 60 per cent. Carriages are subject to an addition of 60 per cent., with a flat rate of 2s. 6d. per vehicle, and merchandise and parcels sent by passenger train an increase of 50 per cent.

Though it has been understood for some time that increased charges would have to be made, few were prepared for such drastic alterations, and it is to be regretted that the Minister of Transport did not give longer notice of and wider publicity to the alterations.

Electricity Supply.

LETTERKENNY Urban Council has applied for sanction to a loan for establishing electric supply works.

BRENTWOOD Urban Council will favourably consider any suitable scheme of electricity supply for the district.

IPSWICH Corporation has received sanction to a loan of £14,000 for consumers' service meters, transformers and switchgear.

BURTON-ON-TRENT Corporation has applied for authority to borrow £6,000 for extending the electric supply cables to the Milton Water Works.

WOLVERHAMPTON Corporation recently decided to purchase some generating plant from the Ministry of Munitions for £40,000, and to apply for sanction to borrow this sum.

BLACKBURN Electricity and Tramways Committee recommend the Council to increase the salary of Mr. P. P. Wheelwright, the Borough electrical engineer, from £800 to £1,000 a year.

The Midland Electric Light & Power Company has abandoned its intention to apply to the Board of Trade for a provisional order for ATHERSTONE, but as soon as the Electricity Commissioners are appointed application will be made for a special order.

A conference of representatives of TORQUAY Corporation and NEWTON ABBOT Urban Council will be held to consider a scheme for the erection of a new generating station, which would supply the whole district with electricity.

In order to minimise the risk of fire at the World's Fair (Islington) the London County Council has insisted that all the showmen's caravans shall be lighted by electricity, and some 50 caravans have therefore been fitted up for electric lighting.

Owing to the difficulty of getting coal, the BUCKINGHAM Electric Light Company has refused to give a guarantee as to lighting any of the lamps in the streets, and it has intimated that if the coal supply does not improve the whole plant will have to be closed down.

As there is sufficient water-power available in the vicinity of DUNOON, a company is considering the question of erecting hydro-electric works. Failing private enterprise, the Council will undertake the work, and construct an electric railway between Sandbank and Innellan.

At the recent inquiry into the application of WEST HAM Corporation for sanction to borrow £164,500 for additional generating and converting plant, mains, &c., it was stated that the electricity department had to obtain 1,000 kw. of electrical energy from the London County Council and from East Ham and Leyton Councils, in order to run the tramcars.

The present lighting arrangements at WAREHAM are far from satisfactory, and Ald. Paul states that the lighting has lately been a mental anguish and mortal agony, and is a source of danger to the public and a great loss to the business community. The Mayor has, therefore, been asked to call a public meeting at as early a date as possible to consider the formation of an electric light company.

Negotiations are proceeding between GREENOCK and GOUROCK Town Councils for the supply of electric current to the latter. A scheme has already been prepared by Mr. F. H. Whysall, Greenock burgh electrical engineer, and will probably be accepted by both authorities. The main extends about half-way to Gourock, and the expense in providing the initial supply will be greatly cut down.

Like many other towns, NOTTINGHAM finds that the demand for electrical energy is increasing and exceeds the capacity of the available generating plant. The tramway service has been curtailed, and consumers have been asked to economise in the use of current for lighting and domestic purposes. The main cause of the trouble is the lack of castings for repairs and renewals, &c., due to the moulders' strike.

The National Association of Colliery Managers has asked the Home Office in view of the abnormal times through which the country has been passing, for an extension of time for the alteration of electrical equipment at collieries. The specified time really expired on Dec. 31, 1919, and in view of the inability of companies and managers to obtain the necessary plant to effect the suggested alteration in the equipment, an extension is considered necessary.

WALSALL Corporation has engaged Mr. E. M. Lacey as consulting engineer for the completion of the Birchills power station. Owing to the increased demand for electric current, it is necessary to place the work in hand at once. In November, 1918, the load was 8,326 kw.; the connections since totalled 1,392 kw., and there are outstanding applications for 1,361 kw., and negotiations are pending for 2,353 kw. By the winter of 1921 the full capacity of the existing plant will have been reached.

The proposal of BURNLEY Electricity Committee to borrow £75,000 for electric supply purposes has been endorsed by the Finance Committee. In view of the prevailing and probable demands for electrical energy and the limited capacity of the present plant, the Committee thinking an early extension of plant is essential. The Committee recommended the purchase of an additional turbo-alternator, three water-tube boilers, economiser, &c., at an estimated cost of £75,000. Application for sanction to borrow this sum has been made.

In consequence of the greatly increased demand for single-phase and direct current in the central area of BRISTOL, the Electricity Committee propose to erect a 2,000 kw. single-phase turbo-alternator with auxiliaries, at the Feeder-road station, at a cost of £28,000. It is also proposed to order a 1,000 kw. d.c. converter, with auxiliaries, for the Temple Backs station, at a cost of £7,835. These machines will take the place of two older machines. On that superseded in Feeder-road, the outstanding debt is £2,719, and on that at Temple Backs £1,317. It is proposed to borrow £36,335, the cost of the two new machines, leaving the electricity department to decide how the £4,036 still due on the old plant shall be dealt with.

Sub-Committees of the STALYBRIDGE, HYDE, MOSSLEY and DUKINFIELD Tramways and Electricity Board, and of Ashton-under-Lyne Corporation, have been appointed in order to prepare a scheme for the formation of a Joint Electricity Authority under the Electricity (Supply) Act of 1919. Sir John Snell thinks that the interests of both Ashton and the Joint Board's area would be best served by supplying the district from one station.

The dispute between the Joint Board and its shift engineers was referred to at the monthly meeting of the Board on Tuesday, and Councillor Bury stated that eight members of the staff had resigned since their last meeting. He said the men were making claims which the Committee could not admit, and the claims were so unreasonable that the senior members of the staff resigned from their union rather than be parties to them. The Committee had, however, agreed to arbitrate on the claims, but the men refused this proposal, and they left the service of the Board.

DUNDEE Electricity Committee may be able to make a small reduction in the charge for electric current for household and domestic consumers as from the 31st ult. The Electrical Engineer (Major H. Richardson) estimates that the reduction would be ·18d. per unit, and the figures will be submitted to the Coal Controller for his approval. The Committee has accepted tenders for the supply and laying of several miles of electric cables at a total cost of £25,000.

At a joint meeting of the Electricity and Housing Committee it was decided to fix the charge for electric light in the Logie houses at 10s. per quarter, and a further charge of ¾d. per unit, plus 15 per cent. on the ¾d. Assuming that a tenant uses 100 units of current per annum, the charge would be £2, plus approximately 7s. It is expected that the cost of lighting to an ordinary tenant will be about 1s. per week.

Now that ROCHDALE Corporation have undertaken to supply electricity in bulk for power a number of firms in the district have availed themselves of the opportunity to convert their method of driving to electricity. Although partial conversions have been numerous during the last ten years, the first of the large cotton mills in the district to make the complete change over in every department is that of Messrs. Holt & Ogden, Ltd. Electricity will be supplied at 3,000 volts, and this will be transformed on the premises and distributed through motors varying in size from 20 to 125 H.P., each being under separate control. Along with the further extensions to their works at Belfield, Messrs. William Tatham, Ltd., have decided to adopt a mixed system of alternating current and continuous current electric power, the supply in the first place being taken from the Corporation mains, reduces from high to low pressure, and again converted from alternating to continuous current for meeting the calls of the variable speed machines. Mr. W. D. Watson's design has been approved by both firms and tenders have been let to the Rochdale Electric Company. Electric power from the Corporation is also to be used in the Ensor No. 3 mill.

Electric Traction.

HALIFAX Tramways Committee has increased the tramway fares to a penny a mile or portion of a mile.

WALTHAMSTOW Urban Council has purchased eight second-hand tramcars from Rotherham Corporation.

ABERDEEN Corporation has requested the Tramways Committee to report upon the terms of the agreement with the Suburban Tramways Company as to running powers over the Corporation lines.

The employees of the RAWTENSTALL tramways department decided that the through running of tramcars between Accrington and Rawtenstall should cease after Dec. 31. This decision was taken without waiting for the approval of the Rawtenstall Tramways Committee.

The work of converting the LINCOLN tramways from the surface contact to the overhead system has been completed. The only tramways in this country now operated on the surface contact system are those of the Wolverhampton Corporation.

BLACKPOOL Corporation took over the Blackpool and Fleetwood Tramroad Company on the 1st inst. No alteration has been made in the services and the cars will be run as hitherto until the end of the financial year on March 31. In the meantime the general manager (Mr. Chas. Furness) will report upon the system and its administration.

The Board of Trade has granted an EXTENSION OF TIME until Aug. 7, 1920, for the exercise of powers of compulsory purchase of lands and for the construction of works authorised by the London Electric Railway Act, 1913, and the periods limited by the London Electric Railway Act, 1914, for the completion of works authorised by the Act and for the exercise of powers for compulsory purchase of lands are extended by one year from July 8, 1919.

BRADFORD Corporation placed an order with Messrs. Brown, Boveri & Company, in 1915, for the supply of 200 car motors which the contractors subsequently were unable to fulfil on account of conditions arising out of the war. It has now been mutually agreed as the result of friendly discussion between the parties, that as the contractors cannot guarantee delivery of the motors by next summer, the work shall not be proceeded with. The Tramways Committee have accordingly passed a resolution recommending that the contract in question shall be cancelled by the mutual consent of the parties.

Miscellaneous.

The Board of Trade announce that Roumania has been added to the list of countries to which the EXPORT CREDITS SCHEME applies.

The section of the All-American submarine telegraph cable between Monte Video and Buenos Ayres was opened to traffic on Saturday last.

We regret to record the death which occurred on the 24th ult., of Mr. Claud Hamilton, managing director of Messrs. Claud Hamilton, Ltd., electrical engineers, of Glasgow.

A commercial wireless telegraph service has been inaugurated between Barrington Passage, Nova Scotia, and the British Government station at Bermuda.

Amongst the new Acts of Parliament which received the Royal assent last week were the Trade Marks, the Patents and Designs and the Electricity (Supply) Acts.

The near relatives of their employees who fell in the war were entertained to dinner last week by the St. Helens Cable & Rubber Company, of Warrington, and employees who had subscribed. An illuminated Christmas tree, laden with toys, was provided for the children.

The Privy Council has granted a charter of incorporation to the Technical College at Swansea, raising it to university rank. Swansea is raising £150,000 for the endowment of the College.

The U.S.A. Senate recently passed a Bill authorising President Wilson to call an "International Communication Conference" to consider submarine cable rates and other questions proposed by the representatives of the Allies and the United States in Paris. The conference is expected to deal with the disposal of the German submarine cables.

Messrs. Chamberlain & Hookham, Ltd., held a most enjoyable staff ball on Friday, Dec. 19 at the Imperial Hotel, Birmingham. Some 130 members of the staff and their friends were present, many of the former having only recently returned from the fighting services. The whole of the arrangements were excellently carried out and the evening was in every way a pronounced success. Mr. W. S. Sprague, managing director of the company, acted as M.C., and his able guidance contributed in no small measure to the evening's enjoyment.

There was no service of tramcars in Oldham on Christmas Day and the opportunity was taken by the employees to hold a social gathering, at which they welcomed back their colleagues who had been on war service. The men had already raised £100, and the Tramways Committee made a grant of £75. In the morning a memorial tablet was unveiled at the Mumps depot by Coun. Cheetham, chairman of the committee, and in the afternoon the employees and their wives, families and friends enjoyed tea, a concert and a dance, whilst the children received presents from a Christmas tree.

Catalogues, Business Items, &c.

The works of the Electric Control, Ltd., closed from midday, Dec. 31, 1919, until Thursday, Jan. 8, 1920, but the offices will be reopened on Monday, Jan. 5.

We are informed that the business of Connolly Brothers, Ltd., Blackley, Manchester, was taken over by Messrs. Connolly (Blackley), Ltd., as from July 1 last. The function of the receiver will therefore shortly cease, and his final account lodged in Court.

The title of Edison Accumulators, Ltd., has been altered to the Edison Accumulator Company, Ltd., and the address is now 15, Upper George-street, Edgware-road, London, W.2.

In the December issue of "Installation News," the quarterly house journal of Simplex Conduits, Ltd., there are interesting notes on standards, the Simplex fuse unit, the Plexsim electric hot bar fire, and other manufactures of the company.

In a pamphlet issued by Messrs. Verdon, Cutts & Company, 87, Fargate, Sheffield, illustrated particulars are given of the firm's welding plant, which is claimed to be simple in operation and also efficient and economical.

The British Insulated & Helsby Cables, Ltd., of Prescot and London, have recently issued a special edition of their catalogue dealing with cables and wires, junction boxes, fuses, tramway and overhead line material, insulators, &c. There should be a good demand for the company's well-known products in Spain and South America, and the issue of the catalogue in Spanish will assist in developing their business in those countries.

A well-printed pamphlet on "Housing Construction and Electricity Supply" has been issued by the Electrical Development Association, Hampden House, 84, Kingsway, London, W.C.2. The advantages of electricity for lighting and for heating, cooking and other domestic purposes are stated clearly and succinctly; and,in view of the numerous housing schemes which are projected, the publication is a timely one. Copies of the pamphlet may be obtained from the director and secretary of the association, Mr. J. W. Beauchamp, M.I.E.E.

We have received from the General Electric Company, Section "H" of the 13th Edition of their general catalogue. This deals with electric heating and cooking appliances and gives in excellent fashion a full description of all the apparatus coming under this heading which is made by the Company, including such things as magnet electric fires, lamp radiators, convectors, kettles, "quick" water boilers, grillers and toasters, warming plates, irons and sealing-wax heaters. It should be in the hands of everybody interested in this class of work.

We have also received from the General Electric Company, specifications dealing with the Salford automatic circuit breakers and with their continuous current motor starters of the face plate type.

Tenders Invited and Accepted.

Carlisle Corporation require tenders by Jan. 5 for wiring 24 houses. Particulars from the City Enigneer.

Tenders are required by Jan. 12 for electric light wiring in connection with Glasgow Corporation's Coplawhill area housing scheme. Schedules, &c., from the City Electrical Engineer.

Bootle Corporation invite tenders for wiring the first 34 houses under their housing scheme. Specifications from the Borough Electrical Engineer, and tenders to Town Clerk by Jan. 7.

Gisborne (N.Z.) Council require tenders by 4 p.m., Feb. 2, for the supply of two storage battery tramcars. Specifications from the Town Clerk.

Sydney (N.S.W.) Council require tenders by 3 p.m., March 1, for the supply of two 2,000 p.v.a., 5,000-10,000 volt transformers (contract No. 571). Specifications from the City Electrical Engineer.

Manchester Electricity Committee require tenders by Jan. 14 for a 2-ton electric lorry and a 10-15 cwt. electric van. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Bradford Corporation want tenders by Jan. 28 for supply of two electric battery locomotives. Particulars from Mr. J. Garfield, Esholt Hall, Shipley.

Auckland (N.Z.) Harbour Board require tenders by noon, Sept. 1, 1920, for supply of 12 5-ton (and alternatively 3-ton) semi-portable balanced-jib, level luffing electric cranes, &c. (contract 702).

Tynemouth Corporation invite tenders for ten 250-k.v.a. transformers. Specifications from Mr. C. Turnbull, borough electrical engineer, Electricity Works, and tenders to the Town Clerk, Mr. Stanley Wilson, by Jan. 12.

Camberwell (London) Council require tenders by 5 p.m. Feb. 2 for 12 months' (or alternatively three years') maintenance of private telephones and electric bells at the Town Hall. Forms of tender from the Borough Engineer.

Tenders are invited for electric lighting plant at Cavan, including suction gas engine, electric generator and motor booster, storage battery, switchboards, &c. Specifications from tenders to Mr. P. Reilly, Hon. Sec., Cavan, by Jan. 12.

Islington (London) Council require tenders by noon Jan. 28 for one year's supply of stores for their electricity department, including cables, meters, lamps, transformers, carbons, &c. Specifications can be obtained at the Town Hall.

Halifax Corporation want tenders by Jan. 5 for 13 months' supply of tramway stores, including lighting fittings, insulating materials, v.r. cable, wires, trolley and overhead line materials, castings, &c. Forms of tender from the Tramways Engineer.

Dundee Corporation invite tenders for supply and erection of three 750 kw. and one 300 kw sets of rotary converting machinery, and one 12-panel, 11,000 volts e.h.t. switchboard, and three D.C. machine control panels. Specifications from the General Manager and Engineer. Tenders must be lodged with the Town Clerk by Jan. 23.

The Electricity Committee of Hull Corporation invite tenders for the supply and erection of a 10,000-kw. turbo-alternator with exciter and one condenser outfit. Forms of tender from the City Treasurer, Mr. T. G. Milner, and tenders, addressed to the Chairman of the Electricity Committee, Guildhall, Hull, must be in by Jan. 23.

Barnes Urban District Council invite tender for the supply of water-tube boilers, economisers, draught plant, turbo-alternators, condensers, air and circulating pumps, transformers and rotary converters. Specifications from Mr. C. S. Davidson, M.I.M.E., M.I.E.E., Electricity Works, High-street, Mortlake, S.W.14. Tenders by noon of Jan. 12.

Stepney (London) Electricity Supply Committee invite tenders for manufacture and erection of two water-tube boilers, economisers and other accessories, and one 5,000-kw. turbo-alternator condenser, accessories and switchgear. Specifications from Mr. Wm. C. P. Tapper M.I.E.E., borough electrical engineer and manager, and tenders to the Chairman of the Committee, 27, Osborn-street, Whitechapel, E., by noon, Jan. 22.

Bolton Electricity Committee has placed an order for four boilers, with superheaters, stokers, &c., with Messrs. Babcock & Wilcox.

Walsall Corporation has accepted the offer of the Chloride Electrical Storage Company for supplying and fixing at Hospital-street, Sub-Station a new battery at £1,584 10s. less the scrap value of the old material.

Shoreditch (London) Borough Council has placed an order for the supply of one 1,000 kw. rotary converter with the Metropolitan Vickers Electrical Company at £4,930, and for four 1,500 kw. motor converters with Bruce Peebles & Company at £7,039.

Leeds Electricity Committee has accepted the tender of the British Electric Transformer Company for 46 transformers at £19,704, and also for further transformers as required during the two years ending December, 1921; and that of the W. T. Henley's Telegraph Works Company for 8 miles of cable at £7,540.

Tunbridge Wells Corporation has accepted the following tenders:—British Thomson-Houston Company, Ltd., switchboard, £1,835; Green & Sons, economiser, £1,322; Keith & Blackman Co., induced-draught plant, £255; Fraser & Chalmers, 1,000 kw. turbo-alternator set, £9,788; Aiton & Company, pipe work, £2,184; Mirrlees Watson, Ltd., surface condenser and steam ejector pumps, £3,500.

Personal.

At Birmingham presentations were made on Thursday to **Sir Oliver** and **Lady Lodge** in recognition of the great services rendered to education by Sir Oliver while principal of the University of Birmingham. The Lord Mayor, who presided over a large and representative meeting of scientists and of business men, made the presentation, which included an illuminated address.

The Council of the **University of Birmingham** has elected **Mr. William Cramp**, D.Sc., M.Sc.Tech., M.I.E.E., to fill the chair of electrical engineering recently vacated by Dr. Kapp. Dr. Cramp was for some years on the staff of Messrs. Ferranti Ltd., of Hollinwood, and on leaving that firm he became lecturer and demonstrator under the late Prof. Ayrton, at the Central Technical College, London. Later he held a similar appointment at the Manchester College of Technology, but has for many years carried on a successful consulting practice (latterly in partnership with Mr. Julius Frith) in Manchester. He is a past chairman and an active member of the North-Western Territorial Centre of the Institution of Electrical Engineers, and one of the original promoters of the Engineers' Club, Manchester. He is the author of books on electrical design and alternating-current work, and has carried out researches in electrical and electro-chemical processes which have been embodied in a number of technical and scientific papers.

General regret will be experienced by the many friends of Mr. F. T. **Preddle** when they learn of the retirement from official life for which he made application to his directors in July last. Born in November, 1850, he joined the service of the Direct Spanish Telegraph Company in June, 1873, was appointed Secretary in May, 1902, and retired on Dec. 31, 1919, his total service being thus between 46 and 47 years. Mr. Preddle attended the International Telegraph Conferences in London in 1903 and at Lisbon in 1908, and in Jan., 1908, the King of Spain conferred upon him the Knighthood of the Royal Spanish Order of Isabel la Catolica in connection with the visit to this country of His Majesty in 1907, and in recognition of services previously rendered to the King and his Royal Mother. Mr. Preddle was "Hail fellow well met" with all with whom he came in contact, and his numerous friends will greatly miss him. We hope he may yet live many years to enjoy the rest he so richly deserves. Mr. C. E. Morgan succeeds Mr. Preddle as Secretary of the Direct Spanish Company.

Ald. G. Pearson, chairman of the Bristol Corporation Electricity Committee, who has for the past 14 years acted as **Honorary Solicitor to the Incorporated Municipal Electrical Association**, has recently, much to the regret of the Association, been compelled to resign owing to indifferent health. The Council of the I.M.E.A. announce that Mr. P. M. Heath, Deputy Town Clerk of Manchester, has consented to accept the position.

Rochdale Gas and Electricity Committee has granted a further two months' leave of absence to the borough electrical engineer (Mr. F. H. **Rudd**), who has not yet recovered from a nervous breakdown. During the three years he has had control Mr. Rudd has had a trying time, and the committee feel that his breakdown is mainly due to his devotion to duty.

On leaving the Aberdeen Corporation Electricity Department to take up duty as shift engineer with the Falkirk Corporation, Mr. **Harry Trowsdale** was presented on the 26th ult. with a watch and chain as a parting gift from his fellow employees. Mr. Bullman, station engineer, in the absence of Mr. Bell, made the presentation.

On the occasion of their silver wedding Mr. G. F. **Moller**, general manager of the Lanarkshire Tramways Company, and his wife were presented by the tramway employees with a silver tea and coffee service and a pair of silver vases.

Appointments Vacant and Filled.

The Sudan Government Railways and Steamers Department require a foreman electrician. Commencing salary £E300 per annum, plus war bonus of £E96.

Stoke-on-Trent requires a commercial assistant to the Borough Electrical Engineer and Chief Clerk. Salary, £300 per annum. Particulars from the Engineer.

An assistant lecturer in electrical engineering is required for the technical schools of the Plymouth Education Authority. Salary £200, rising to £370, per annum. Particulars from the secretary, Mr. E. Chandler Cook. Applications by Jan. 14.

Cardiff Corporation invite applications for the position of city electrical engineer, salary £1,000, rising to £1,250 per annum; and also for the position of tramways general manager £800, rising by annual increments of £50 to £1,000 per annum). Applications, on forms to be obtained from the Town Clerk (Mr. Cecil G. Brown), must be in by Jan. 15.

A chief lecturer in electrical engineer (£350, rising to £400 per annum), an assistant lecturer in civil and mechanical engineering (£300) and an assistant lecturer in physics (£300) are required at West Ham Municipal Technical Institute. Applications to the Principal, Romford-road, Stratford, E.15, by Jan. 12, 1920.

Hull Tramways Committee has appointed Mr. Charles F. Ellwood, of Salford, to the position of traffic superintendent.

Mr. J. Brierley, formerly traffic superintendent of the Rhondda Valley tramways, has been appointed tramway traffic manager to the Southampton Corporation.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

120,914 Harlow. Electrically-operated diaphragm vibrators, particularly applicable for signalling devices in factories and like places. (21,11 17

133,291 Scintilla. Cable outlets of magneto electric ignition machines for internal-combustion engines. (1 10 18.)

134,193 Automatic Telephone Mfg. Co. Automatic or semi-automatic telephone systems. (23 10 18

134,609 Joel. Dynamo-electric machines. (4 11 18.)

134,614 Mortley. Aeronautical dynamos. (5 11 18.)

134,620 Mossay & Enclosed Motor Co. Dynamo-electric machines. (6,11 18.)

134,632 Green. Electric heaters. (12 11 18.)

134,633 Joyce & Park Royal Engineering Works. Adapter or connector for electric wires. (12 11 18.)

134,639 Berry & Reid. Electric heating devices. (14 11 18.)

134,640 Krauer. Chairs for the electromagnetic treatment of the human body. (14 11 18.)

134,644 Hinton & Radio Communication Co. System of wireless direction finding. (22 11 18. Cognate application, 12,373/19.)

134,648 Ozaki. Electric incandescent lamps. (25 11 18.)

134,680 Wade. (Fabbrica Isolatori Livorno.) High-tension insulators. (19 12 18.)

134,689 Beavan. Electric ignition apparatus for internal-combustion engines. (30 12 18.

134,691 Summers Summers & Summers. Fire-bar or heating element deriving its heating ability from electrical energy. (2 1 19.)

134,712 Rackham. Method of driving magneto on internal combustion engines. (31 1 19.)

134,725 Ehret. Method of and apparatus for controlling electrical energy in signalling systems and the like. (20/2 19.)

The electric energy controlled, amplified or produced by an audion or similar device is controlled by changing or varying both the emission of electrons and the flow of the electrons. This may be effected by controlling the temperature of an electron-emitting cathode and the potential of the grid or screen electrode.

134,739 Goldstone & Farrell. Magneto generators. (12,3/19.)

134,760 Loon. Pull socket electric switches. (23/4 19.)

134,780 Automatic Telephone Mfg. Co. (Automatic Electric Co.) Telephone and telegraph systems. (30,5 19.)

134,809 Tucker & Crabtree. Electric switches. (3 10 18. Divided application on 16,054 18.)

1919 Specifications.

120,891 Burgess Battery Co. Manufacture of electric dry batteries. (30 10,17.)

124,438 Stabilimenti Bank-Ing. Pouchain. Electric furnace for heating, annealing or melting metallic materials. (9 3, 18.)

127,587 Remy Electric Co. Distributor devices for ignition apparatus. (4 4, 17.) (Divided application on 219 19.)

128,189 Splitdorf Electrical Co. Ignition devices for internal combustion engines. (8 6 18.)

129,625 Marconi Wireless Telegraphy Co. Radio signalling apparatus. (12 7 18.)

Comprises a plurality of loop or other antennæ extending substantially horizontally in opposite directions, or located in substantially the general direction of transmission, and receiving apparatus for utilising the signal waves, including means for eliminating the interference due to static disturbances, or for balancing out the currents due to such disturbances, preferably while retaining the signals.

130,333 Remy Electric Co. Electric ignition apparatus for internal combustion engines. (19 9 17.)

134,338 Hunt. Detector of varying magnetic fields with application to vibration galvanometers or oscillographs. (4 11 18. Cognate application, 10,943 19.)

134,341 Whiddington & Eckersley. Electromagnetic wave transmitting and receiving systems. (4 11 18

Comprises a closed oscillatory circuit tuned to the period of the oscillations which it is desired to receive, so placed between the aerial and earth that the impedance of the two branches of the divided aerial circuit so formed are of different values, whereby oscillations of a periodicity differing from that to which the closed circuit is tuned pass to earth by the branch having the least impedance, and do not affect the detector circuit which is inductively coupled to the branch having the greater impedance.

134,342 Robinson. Wireless direction-finding arrangements. (4 11 18.

134,353 Brown. Telephone receivers. (9 11 18.)

134,354 Jones. Ward-Leonard system of electric driving. (11 11 18.)

134,364 Quarmby. Holders for incandescent lamps. (14 11 18. Addition to 18,476, 17).

134,365 Automatic Telephone Mfg. Co. & Redfern. Electrical sound-detecting devices. (15 11, 18.)

134,376 Coates, Dale & British Westinghouse Electric & Mfg. Co. Electric switches or circuit interrupters. (19 11 18.)

134,422 Campbell. Electric furnaces. (23 12 18.)

134,443 Tritschler. Searchlight device for stage use. (21 1 19.)

134,444 Western Electric Co. Repeating or amplifying systems, particularly applicable for telephony. (21 1 19.)

134,469 Partington. Electric igniter. (10 3 19.)

134,472 Marchiaro. Electrically-heated soldering bits. (24 3, 19.)

134,476 Naylor & Tyler. Miners' electric lamps. (1 4 19.)

134,497 Regnauld de Bellescize. Wireless telegraphy stations working on the duplex system. (22 1 19.)

134,505 Angold. Electric coupling or connecting device. (2/7 19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

October 9, 1919.

24,724 Schroder. Electrical seam welding machines. (30 5, 18, Germany

24,732 B.T.-H. Co. (G.E. Co.) Stationary electric induction apparatus.

24,736 Chandler. Wireless receiving apparatus.

24,738 Societe d'Electricite Mors. Electrical apparatus for operating railway signals.

24,744 Electrolytic Zinc Co.

October 10, 1919.

24,750 Vincent. Locking device for electric switches.

24,773 Marshall. Electrically-operated doormat.

24,789 Tigerstadt. Transmitting signals, speech, &c. (10 10 18, Denmark.)

24,780 Halden. Electric photographic printing, &c., machines.

24,813 Soc. Anon des Ateliers de Secheran. Electric resistance heaters for high temperatures. (10 10 18, Switzerland.)

24,815 B.T.-H. Co. (G.E. Co.) Electric heating apparatus.

24,816 Western Electric Co. Printing telegraph systems.

24,831 Portable Electric Current Patents Co. Dry battery cells. (10 1 18 U.S.)

24,838 Wig. Testing magnetisable objects.

24,844 Hood. Current distributors or commutation of ignition systems.

24,845 Marks. (Vlug.) Apparatus with Variable Self-inductance.

24,856 Kessler & Hammond. Electric plug.

October 11, 1919.

24,864 Lewis. Trolley head.

24,903 Lepine. Wiring systems for electric light and power installations

24,931 Western Electric Co. Machine switching telephone systems.

Companies' Reports, &c.

The directors of Messrs. Crompton & Company, Ltd., have declared an interim dividend at the rate of 7 per cent. per annum for the six months ended Sept. 30, 1919, on the preference shares, payable Jan. 5.

The directors of the Eastern Extension, Australasia and China Telegraph Company, Ltd., have declared an interim dividend for the three months ended Sept. 30 of 3s. per share (tax free), payable on Jan. 15.

The Société Anonyme Intercommunale Belge d'Electricité Brussels, which is interested in a number of electric supply stations in Belgium, is to increase its capital from 4,000,000 to 10,000,000 frs. by the issue of 12,000 new shares of 500 frs. each.

The Guanajueto Power and Electric Company and its subsidiaries the Miehoacan Power Compgny and the Central Mexico Light and Power Company propose to pay two additional overdue coupons of the bond issue of each company.

The Burmah Electric Tramways and Lighting Company, Ltd., has declared a dividend of 10 per cent. (10s. per share), less tax, on the preference shares for the period ending July 31, 1911; £8,000 has been placed to depreciation reserve, and £750 to depreciation of investments; a sum of £492 being brought forward.

The gross receipts of the Manx Electric Railway Company for year ended Sept. 30 last were £57,102, gross expenditure was £26,601 and profit £31,501. The debit balance was £31,411, leaving £90, and after deducting this from interest on first debentures (£9,000) there remains a debit balance on revenue account of £8,910. It is proposed to resume cash payments for the half-year's interest due on April 1 next for both the first and second debentures, together with the interest on the latter which has accrued since date of issue.

The trading profit of the Barbados Electric Supply Corporation, Ltd., for the year ended June 30, 1919, amounted to £3,600, compared with £3,197 for the previous year. A sum of £1,303 has been charged for repairs and renewals compared with £484. Capital expenditure amounted to £1,854, and to meet the growing demand and to provide sufficient spare plant to enable systematic overhaul work to be carried out with a minimum of inconvenience to consumers, the directors are installing an additional set of 225 kw. Negotiations are being resumed with the proprietors of the local tramway system.

Mr. E. Lloyd Pease, who presided over the annual meeting of the Power Gas Corpn., Ltd., last week, stated that there had been an increased output in the manufacture of compact and comparatively small gas plants for producing gas for manufacturing and power purposes. To a company like theirs, identified with the supply of power, the present position of the question of cheap power and the proposal to erect super-stations and attendant limitations to freedom of action contained in the Electricity Bill was a subject of special interest. There was a widely spread feeling that the present was not a favourable one for engineering experiments on a large scale. To many persons it would appear that such a large expenditure as was proposed would be only justifiable if a great economy were certain to be realised. The view had been expressed by several authorities that, while capital outlay on large central electric stations would be justified for the supply of power to railways and for electrolytic processes, to regard them as the best means of electric generation for universal requirements was a mistaken view.

The report of the British Mannesmann Tube Company, Ltd., for the year ended June 30, 1919, states that the manufacturing profit, after deducting works charges and depreciation, was £150,144, and with interest, &c., and balance brought forward (£65,905), the total was £228,645, and after deducting administration expenses (£43,571) the balance was £185,073. After meeting debenture interest and other charges, and transferring to reserve £10,000, the balance was £138,719. Deducting preference dividend and interim dividend to Dec. 31, 1918, of 4 per cent., the balance was £106,769. It is proposed to pay a final dividend of 4 per cent. and a bonus of 1 per cnet., making (with interim dividend) a total of 8 per cent. per annum, plus a bonus of 1 per cent., leaving to be carried forward, £72,769. Since the cessation of hostilities the Landon works have been operated to the full capacity; the demand for British-Mannesman tubes has been much in excess of production and the output has been unavoidably hampered by the change from war to peace conditions and by shortage of raw materials. Progres at the Newport works has likewise been impeded by difficulties in obtaining delivery of plant and material. The directors recommend an increase of the share capital to £2,000,000 by the creation of 1,320,000 ordinary shares of £1 each.

The directors of Bullers, Ltd., have issued a report covering the years ended July 31, 1916, 1917, 1918 and 1919. The business has been maintained with great success in spite of the abnormal difficulties presented by the war. The conversion of the works from war to peace conditions has been most satisfactorily accomplished, and, in addition to the special depreciation allowed by the Government a further amount of £5,000 has been hypothecated to meet the altered conditions of the Hanley works. In order to deal with the great increase in the volume of business new works at Milton are being erected, and are nearly complete, which will be equipped to employ the most recent scientific methods and to manufacture material which has been hitherto largely imported from the Continent. All the surviving employees who were called up have been reinstated, and an agreed proportion of disabled soldiers has been taken into the service of the company. The accounts for 1916, 1917 and 1918 have been adjusted, and a final balance of £9,442 17s. 10d. has been brought forward. For the year 1916 a dividend of $7\frac{1}{2}$ per cent. was paid on the ordinary shares, and for 1917 and 1918 10 per cent. was paid. The accounts, after payment of directors' fees, salaries, &c., and after providing for excess profits duty, show a profit of £32,652 18s. 1d., which, with £9,442 17s. 10d. brought forward, makes a total of £42,095 15s. 11d. The directors recommend that a further dividend of $7\frac{1}{2}$ per cent., making $12\frac{1}{2}$ per cent. for the past year, be paid on the ordinary shares; that £10,000 be placed to reserve, a further allocation of £5,000 against contingencies at Hanley, and the balance of £845 15s. 11d. be carried forward. The dividend of 5 per cent. on the preference shares has been paid.

At the statutory meeting of Ward & Goldstone, Ltd., which was recently held at Manchester, Mr. M. H. Goldstone presided and stated that the state of their order book was very healthy; in fact, they were booked up at profitable rates in most departments for a long time ahead. The demand for wires, cables and flexible cords continued in excess of the supply. Not only was there a continued increasing demand for cables for lighting, heating, power, telephone and bell service, but the automobile industry requirements were very substantial, and the directors were making provision in the new works for increasing the output. In the departments relating to switch and fuse gear, owing to the heavy stocks of castings they usually carried, they had, as yet, not been seriously handicapped by the moulders' strike, but unless that trouble was soon settled, he feared that department was likely to suffer. The demand for their electrical plants for lighting country houses, bungalows, cinemas, &c., was growing, and the directors looked to that department to supplement their profits to a considerable extent. In spite of the competition of American and other makers, their lighting sets were so dependable and reasonable in price that they had little fear of fair competition. They were anxious to remove to their new works, and they hoped to start moving in April next, and as it was intended not to stop production during removal they were duplicating a portion of their machinery. The turnover continued to increase satisfactorily, and the directors were optimistic as to the future prospects.

At the recent meeting of the Low Temperature Carbonisation, Ltd., the managing director (Mr. H. L. Armstrong), who presided, stated that their engineering staff had reported in September that the claims made in the past for the company's process were fully justified, and therefore negotiations were commenced for several large schemes to erect plants as soon as industry had settled down. A contract had been arranged with the Yorkshire Electric Power Company to erect a plant and supply all the gas that can be made from the carbonisation of 500 tons of coal per day. That gas was to be burnt in the company's boilers in place of raw coal, and they were supplying the gas at a price which showed a great saving over coal. He assured his hearers that through that contract a great industrial awakening was foreshadowed. Negotiations were then begun with an influential group of manufacturers in a great industrial district in Scotland, and their scheme immediately found favour with the parties interested. Assurances had been given that consumers whose aggregate consumption was 4,000-5,000 tons of coal per week would purchase gas from a super-carbonising station as soon as erected. They were getting out a plan by which the scheme could be worked on co-operative lines. Negotiations were also practically complete for the erection of a plant to carbonise a minimum of 500 tons of coal per day near Sheffield. Although in all those schemes the only arrangements were those which had been made to sell the gas, large quantities of motor spirit, oil, smokeless fuel, sulphate of ammonia, chemicals, &c., would also be made and marketed. Work upon the above plants was expected to start next year, and would probably be handled by subsidiary companies. They had modernised and redesigned their plant at Barnsley.

Mr. H. Kahn, who presided over the recent annual general meeting of the shareholders of the Aron Electricity Meter, Ltd., stated that the chief assets of the company consisted of their factories in Schweidnitz and Charlottenburg, which were incorporated into a German company, of which the Aron Company held all the shares. Some time after the outbreak of war those shares were sold by the German Public Trustee to German subjects, and all they had to show for those assets was their claim on the British Government for their book value plus goodwill. That claim had not yet been adjudicated on. They had also a factory in Vienna, constituted as a company on similar lines. The shares still belonged to them, but were of greatly reduced value, inasmuch as the concern sustained a serious loss owing to the tremendous fall in exchange in kronen when the mark was still high, and when the Vienna company was called upon to liquidate its accumulated debit balance for goods supplied by the Germany company. The Vienna company also ran the Hungarian branch at Buda-Pest, which at the time was seized by the then Soviet Government, but on the fall of the latter was released, and was working again under its own administration. Their French company, which had never been a particularly remunerative concern, was now being liquidated. Their Belgian branch, also a limited company, and the shares of which were held by the French company, had most of its realisable assets confiscated by the Germans. In that case a claim had been lodged with the French Government. Their Italian branch was likewise a limited company, but the shares were held by the German company. That small branch, which had also been directly managed by the German company, would have to be adjusted when the settlement was made. The English factory, which before the war rarely showed a profit, now, together with the Taximeter Company, had made sufficient profits to pay interest on the debentures and on the unsecured loan, as well as all head office expenses. The results of the current year would be better than during the past few years. The future of the company was dependent on the result of the adjudication of their claim against the British Government for the loss of their German assets.

New Companies.

B. E. E. ELECTRIC MOTORS, LTD. (161,749). Private company. Reg. Dec. 17, capital £20,000 in £1 shares, to carry on the business of buyers and sellers of and dealers in all kinds of vehicles, ships and vessels (whether propelled by electricity, steam or other power), and all electric or other motors, &c. Solicitor, C. E. W. Ogilvie, 32, Essex-street, Strand, W.C. 2.

BRITISH ARIS SPARKING PLUG COMPANY, LTD. (161,966). Private company. Reg. Dec. 22, capital £5,000 in £1 shares. Objects: to carry on the business of manufacturers and importers of and dealers in sparking plugs and all kinds of mechanical or electrical machinery, turbines, dynamos, &c., and to enter into an agreement with Societé Aris, of Lyons. Permanent directors are: J. P. Edmunds, H. H. Deacon, F. H. Bridge, A. S. Shedden, H. J. Edmunds and A. L. Rhys-Evans (also secretary). Reg. office: 65-8, Merchants-exchange, Bute Docks, Cardiff.

BRITISH BRASS FITTINGS, LTD. (161,968).—Reg. Dec. 22, capital £350,000 in £1 shares. Objects: to take over the businesses of Sperryn & Company, Chas. Joyner & Company, Ingram & Kemp, and Player & Mitchell, with certain of the assets thereof (the purchase considerations being respectively £95,644, £45,395, £28,164 and £23,872), and to carry on the business of brass and iron founders, water, gas and electric fittings manufacturers, &c. The first directors are: G. Sperryn, G. M. Sperryn, H. B. Butler, D. E. Grubb, W. J. G. Sperryn and W. Dampier; acting secretary, H. B. Butler.

BRITISH ELECTRICAL REPAIRS, LTD. (161,905). Reg. Dec. 20, capital £50,000 in £10 shares. Objects: to carry on business as indicated by the title. First directors are: J. J. Atkinson, H. C. Evans, N. Fletcher, L. V. Gerrard, H. M. Longridge, M. H. Maxwell and H. F. Taylor. Reg. office: 24, Fennal-street, Manchester.

OWEN MAGNETIC TRANSMISSION SYNDICATE, LTD. (161,159)—Private company. Reg. Dec. 1, capital £12,000 in £1 shares. Objects: To finance the acquisition and sale of patents and to promote companies, rubber and oil companies, &c. Sec.: G. Elliott. Solicitor: A. P. Paine, 20, Essex-street, W.C.

PERNA ENGINEERING WORKS BLACKPOOL) LTD. (161,690).—Private company. Reg. Dec. 15, capital £3,000 in £1, shares. Objects: To take over the business carried on at Blackpool, as the "Perna Engineering Works," and to carry on the business of general and electrical engineers, manufacturers of Perna electric dynamos, lighting sets and other Perna specialities, &c. First directors are: G. H. Morris, W. S. Pyrah and R. H. Mann. Reg. office: Castlegate, South Shore, Blackpool.

PREMIER ELECTRIC WELDING COMPANY (NEWCASTLE), LTD. (161,602). Private company. Reg. Dec. 12. Capital £60,000 in £1 shares. To carry on the business of welders of metals and other substances by electrical, oxy-acetylene or other process, electrical and general engineers, &c. Solicitors: Bircham & Company, 46, Parliament-street, S.W.

STAR ELECTRICAL ACCESSORIES, LTD. (161,256)—Private company. Reg. Dec. 3, capital £10,000 in £1 shares (5,000 7½ per cent. cumulative preference). Objects: To carry on the business of electrical, civil and sanitary engineers, electricians, &c. Reg. office: 13, Frederick-street, Birmingham.

Prices of Metals, Chemicals, &c.

TUESDAY, Dec. 30.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£120 0 0	£5 0 0	—
Electrolytic bars ...	,,	£121 0 0	£3 0 0	—
H.C. wire basis......	per lb.	1s. $4\frac{5}{16}$d.	$\frac{3}{8}$d.	—
Sheet	,,	1s. $4\frac{1}{2}$d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. $8\frac{5}{16}$d.	$\frac{5}{16}$d.	—
Brass 60/40—				
Rod, basis	,,	0s. $10\frac{3}{8}$d.	$\frac{5}{8}$d.	—
Sheet, basis	,,	1s. $2\frac{5}{8}$d.	—	—
Wire, basis	,,	1s. $2\frac{1}{2}$d.	—	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£34 10 0	—	—
Lead Pig—				
English	,,	46 10 0	£1 10 0	—
Foreign or colonial	,,	45 12 6	£1 17 6	—
Tin—Ingot	,,	338 0 0	£12 10 0	—
Wire, basis	per lb.	0 4 $1\frac{1}{4}$	$1\frac{1}{4}$d.	—

Salammoniac.—Per cwt. 95s. and 90s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals)—Per ton £72.

Carbon Bisulphide.—Per ton £56.

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—T.N. Orange, 775s.-780s.

Rubber.—Para fine, 2s. 7½d.; plantation 1st. latex 2s. 9½d. lb.

The metal prices are supplied by the British Insulated & Helsby Cable, Ltd., and the rubber figures by W. T. Henley's Telegraph Works Company.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Dec. 30, 1882.]

ETHER. Dr. O. J. Lodge was to lecture on this subject at the London Institution on Thursday night.

ELECTRIC LIGHTING IN ABERDEEN. The principal streets of Aberdeen were lighted for the first time on Saturday last by means of the Brush system of electric lighting.

A HOLIDAY TASK. We present our readers with a puzzle for New Year's Day. What German author defines magnetism thus: "Magnetism is centropheric antagonism, a radical line, 0, -1, the action of the line being cleft at one extremity. Magnetism has its root in the beginning of creating. It is prophesied with tune."

ELECTRIC LIGHTING IN PARIS.—The proprietors of the Bon Marche in Paris have begun to replace gas in some of their departments by the Edison system. Five hundred Edison A lamps will replace as many gas burners in the basement and other parts of the building. It is stated that the telegraph office in the Rue de Grenelle is to be lighted by means of 10 Cance arc lamps.

NEW SECONDARY BATTERY.—A secondary battery, invented by Messrs. Liardet & Donnithorne, has been on view at No. 38, Holborn-viaduct for some days. The main features of this battery are the intermixture of porous lead, deposited either by direct action by means of a galvanic current, or by the action of spelter, with oxides and salts of lead such as may be produced from galena or other lead ore. This mixture is placed in very thin plates of pure lead, and is kept in position by porous plates.

DEATH OF MR. C. V. WALKER.—Mr. C. V. Walker, F.R.S., past president of the Society of Telegraphic Engineers, and telegraphic engineer for the South Eastern Railway Company, died at Tunbridge Wells on Sunday, in the seventy second year of his age. Mr. Walker was one of the oldest telegraphic engineers in the country, and was the inventor of several useful appliances,.

TELEPHONING FROM LONDON TO BRIGHTON.—On Thursday last (Dec. 21), the London Exchange of the United Telephone Company was experimentally connected with the company's exchange in West-street, Brighton, wires being carried there from the railway station. Ordinary post-office telegraph wires were utilised with satisfactory results, conversation being carried on between the two places, and voices recognised. Some induction noises were experienced, but not to any very great extent. Congratulatory messages were received and exchanged between the Mayor and Mr. J. P. Knight, the general manager of the Brighton Railway. Several leading townsmen and men of business also tested the telephone.

FROM AN ARTICLE ENTITLED "DANGERS TO ELECTRIC LIGHTING."—One frequently meets with paragraphs in the non-technical press concerning the—for the most part visionary—dangers from electric lighting, but our theme is the converse of this—the dangers *to* electric lighting. . . . . The danger we would draw our readers' attention to is a danger from within, and we have reason to know it is a very real one. It arises from the desire of certain companies and individuals to do immediate business at any cost, with the result, as the head of a large firm said to us the other day, "I'm sick of the whole thing, and have given orders to have the whole plant cleared out at the end of the week." . . . It will hardly be believed that in what was avowedly a test installation—an installation at the company's own request—there was not a single instrument for measuring current or illuminating power of lamps, even in the roughest way; the leads simply went direct from the dynamo to the department where the light was used.

FROM THE LEADING ARTICLE.—For a long time the patents relating to electric lighting did not constitute more than 5 per cent. of our weekly summaries of recent inventions. Now they are probably nearer 50 per cent. Nevertheless, sufficient progress has been made to show that in a comparatively short time a formidable rival would make its way in public favour to the old-established gas lighting agency. How short that time would be we certainly did not anticipate, but in this we were not singular. If anybody else was wise enough to foretell its extraordinary and unprecedented development in the course of three or four years, all we can say is that we have ungrudgingly helped to make his prophecy come true. The practicability of the electric light is now fully established; its popularity is well assured; all that remains is for scientists and experimentalists to render it tolerably cheap. From week to week our pages testify to the efforts being made in this direction, and when another New Year comes round we doubt not that the record of substantial progress will be as gratifying as it has been in the last.

ELECTRIC LIGHTING IN MINES.—Messrs. Bell Brothers successfully tried for the first time, on Wednesday evening, says the "Newcastle Chronicle" for Saturday last, the electric light for illuminating the works both above and below bank at their Page Bank or South Brancepeth Colliery. The system used is that of the Maxim Weston Electric Light Company, and there are nine lights at bank on the pit heap and in the engine-houses, and 24 underground, 17 of these being in the Brockwell Pit at the shaft bottom, sidings, stables, and engine-house. The other seven are in the Busty Pit, similarly placed to those in the Brockwell. These lights are driven by a double engine, with a pair of 10 in. cylinders with 20 in. stroke, at a speed of 90 revolutions per minute, which gives 800 revolutions on the dynamo. This dynamo is capable of working 90 lights of 25 candle-power each. A second engine is in a forward state, and in the course of another week will be at work, when the whole of the surface works, colliery offices, managers' and engineers' houses, etc., will be illuminated with the electric light. The engines for working the dynamos are driven by steam, obtained from the waste heat of the coke ovens, which are close by.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,173. [Vol. No. 2. LXXXIV.] FRIDAY, JANUARY 9, 1920 PRICE SIXPENCE. *By Post, 7d. Abroad, 9d.*

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Notes.

The Electricity Supply Act in Operation.

If we were not afraid of metaphorical incongruity we should say that Mr. FARADAY PROCTOR had taken the bull by the horns and made the lion lie down with the lamb. For the new Electricity Supply Act was but a few days old when he convened a meeting for the West of England "District" with a view to setting up a Joint Electricity Authority. At least a preliminary success has crowned his efforts. The representatives of both municipal and company undertakings and of the County Councils who attended the meeting at Bristol Town Hall on Friday last came to agreement to form a Joint Authority. Formal resolutions of the municipalities interested and of the Boards of Directors of the Companies in the area thus tentatively submitted, are, of course, necessary, but if the spirit of unanimity which characterised the taking of this preliminary step continues it looks as though the Bristol Joint Authority will be first in the field. The energy and dispatch with which these immediate steps have been taken certainly deserve the warmest encouragement by the Electricity Commissioners. The keynote of the Act throughout has been "urgency"; and it is to be hoped that this will be realised and acted upon on all sides as it has been in the case just cited.

Proposed Technical University for London.

ABOUT a year ago the suggestion was made that the Imperial College of Science and Technology should be turned into a Technical University with the power of granting degrees in science and technology. This important question has again been raised by an influential deputation which waited upon the LORD PRESIDENT OF THE COUNCIL and the PRESIDENT OF THE BOARD OF EDUCATION, and the claims of those who consider that the establishment of such a technical university is necessary have been also put forward in a letter which appeared in the "Times" on December 31, signed by a number of the higher teaching staff of the Imperial College. It will be remembered that the establishment of a new technical university is considered necessary because under the present arrangement a student, say, in engineering has not only to pass the examinations of the college at which he works but those of the university itself in order to obtain a degree, and has as a preliminary to pass the matriculation examination of both college and university. It is further urged that this arrangement makes for rigidity in the curriculum, while the university regulation that external examiners must be appointed to conduct the university, examinations, and the fact that many of the students entering the Imperial College have not matriculated in the university both cause unnecessary hardships. Now it is recognised by the signatories of this letter that the degree is a sign that the student has received the highest kind of training. For this reason they are anxious that every student worthy of this distinction should graduate, but they feel that they and not the London University are the proper authority to award degrees in technical subjects.

Separate Universities a Wrong Policy.

WE entirely disagree with this view, for to use the establishment of two universities, even in so large an area as London, one to grant degrees in arts and science and the other to grant degrees in technology, would be a wrong policy. After all, a degree is only an indication that the recipient has successfully passed through a certain course of study, and its value depends on what that course of study is. There are, for instance, certain diplomas, such as those granted by the Central Technical College of the City and Guilds Institute, by the Royal School of Mines and by the Institution of Civil Engineers which are as valuable to the holder as any degree can be. And surely the claim of the Imperial College authorities to grant degrees without the investigation of an external examiner is not meant seriously. We believe that in every university external examiners are always appointed to assist the professional staff in degree examinations and to referee in uncertain cases. It would be a pity for many reasons if this were not done. We think, indeed, that the real solution of the difficulty in this case is to be found in compromise, and that the difficulties whereby the student has to pass two matriculation examinations and to undergo at the same time a course of study for his college diploma and for his degree examination, and finally to pass two examinations to obtain what are really equal qualifications, could be overcome. That such a state of things should continue is absurd, but it would be regrettable in the last degree if any split should take place, so that we earnestly hope saner councils will prevail. A very slight alteration in the present university statutes should give the necessary solution to the difficulty.

Electric Developments on the North-East Coast.

If there is one place in this country where the use of electric power develops perhaps more rapidly than anywhere else, it is on the North-East Coast. And although during the last few years expansion has been necessarily allowed only when it was for war purposes, now that the country has returned to a state of peace the Newcastle-on-Tyne Electric Supply Company and its associate concerns are making numerous extensions of their network in order to provide for an ever-increasing demand in the counties of Northumberland and Durham. In the area north of Blyth a 20,000-volt cable some 20 miles in length is being laid between Bedlington and Alnwick to supply energy to the new Shilbottle Colliery, and also to certain other collieries near Whittle. Attracted by cheap power, many enterprises are now beginning to put down works in the Tyneside area. Among these is the Newcastle Graphite Company, which is an industry entirely new to Tyneside. The Seaton Delaval Coal Company has a large scheme in hand for the electrification of their collieries at Seaton Delaval and New Delaval, comprising in all five pits. In these pits electrical power will be used for driving the main winding engines, as well as for pumping, ventilating and haulage. At the Pegswood Colliery the management have decided to abandon the use of their own generating station and to take all the electrical energy they require from the mains of the Newcastle Company. We also understand that the Wallsend and Hebburn Coal Company have decided to replace their steam winder at the Rising Sun Pit by an electric winder. This will complete the electrification of the company's winding system, and will give them five electrically-driven winders, representing in the neighbourhood of 6,000 h.p. This colliery company is also proposing to use electric battery locomotives in place of steam locomotives on the pit bank, and will employ the same type of haulage for delivering coal to the houses in the neighbourhood of the colliery. The Newcastle-on-Tyne Electric Supply Company is making arrangements for the supply of still more energy to various shipyards, while it is interesting to note among the many thousand horse-power supplied by them for industrial purposes thier heating and cooking loads are not neglected, and that a large amount of electric cooking apparatus is now installed at various works in the Newcastle-on-Tyne district, and that heating installations in hotels, restaurants, hospitals and business premises are becoming increasingly numerous. All these developments, of course, mean an increase in the capacity of the generating plant installed, and we understand that the Tees Power Station Coy's North Tees power station will shortly be extended by the erection of two 20,000 kw. turbo-generators and the necessary auxiliary plant.

Electricity in Housing.

We have from time to time insisted on the great importance of the introduction of electric lighting, heating and cooking into the houses which we hope will shortly be erected under the National Housing Scheme. The use of electricity in the modern house can, however, go further than this and be applied in addition to what are generally known as labour-saving devices. Now, the "Daily Mail" has been taking a great interest in the housing question, especially from the point of view of the best design of house to erect, and recently offered three prizes of £250, £100 and £50 respectively for the best designs in which labour saving was the primary object. The competition aimed at obtaining a house which, although it might cost more to build in the first instance, would be more economical to run. The prize-winning designs have now been published, and it is interesting to note that the assessors' report that perfection has not yet by any means been arrived at in the matters of labour-saving and simplification in the house, and that out of the 100 per cent. standard set by the assessors the winner of the first prize scored only 88 per cent., so that there is still room for at least a 12 per cent. improvement. All three of the prize-winners are evidently aware of the advantages that can be obtained by the proper employment of electricity in the home. The houses are, of course, to be lighted electrically, but the use of radiators is also suggested, and an interesting point is that these are arranged in recesses and are hung on hinges so that they can be swung out from the wall to permit a person to go behind them with a broom or brush. Electric cooking is also to be employed, and one of the prize-winners has provided in his design for an electrically heated hotplate in the serving hatch so that it is evident every advantage is being taken of the most modern arrangements. In considering this question it may be pointed out that what is usually called labour-saving in houses should really be called labour prevention, because if a house is erected, say, with banisters which require no dusting useless labour is not only saved but prevented. Now, in every house it is not possible to do away with labour altogether, and it is in reducing this necessary labour to a minimum that electricity can and should be made to play a great part.

Municipal Electricity Supply Loans.

One of the minor troubles of the electrical engineer of a municipally owned electricity undertaking is in connection with the periods for which loans on the plant of his undertaking are issued. It has been felt that the periods allowed for some of the items have been made too long, while in others they are too short, and that in fixing them not sufficient attention has been paid to the development which is still taking place in electrical engineering design and construction. This point has doubtless been considered by the Ministry of Health, whose sanction must be obtained by local authorities in England and Wales before loans for electricity supply plant can be obtained, in recently revising the periods on which these loans are issued. As a general rule the following are now the maximum periods allowed :—Generating plant, 20 years ; cables, 25 years ; house services, 15 years ; transformers, 15 years ; switchboards and switches, 17 years ; motor generators, instruments, &c., 15 years ; lamp-posts carrying arc lamps, 25 years, instead of 10 years as formerly ; accumulators, 5 to 7 years, instead of 7 years ; arc lamps, 5 years ; electric motors let on hire, 10 years ; meters, 5 years ; mechanical stokers, 15 years, and not 10 years as formerly. It should be noted that no figures are given for the repayment of loans for boilers, condensing plant, economisers, coal handling plant, cranes and other mechanical handling equipment, nor overhead mains, metal filament lamps and posts for street lighting using these lamps. These are all matters which we hope will soon be dealt with by the Ministry of Health or the Electricity Commissioners so that the whole question may be standardised. For our part we think it inadvisable to raise loans for plant and equipment for periods of less than 10 years, as it is more satisfactory to pay for such plant out of the current revenue. It should be pointed out that the periods given above do not apply to the London area, where more generous terms are allowed, the London County Council and not the Ministry of Health being the sanctioning authority.

The Moulders' Strike.

Since we wrote on this subject last week matters have taken a more hopeful turn, thanks to the active intervention of the Parliamentary Committee of the Trades Union Congress and of Sir Robert Horne. As a result of this intervention the conference between the Engineering Employers' Federation and the Executives of the three trades unions concerned was reopened on Friday last, and after a full day's discussion it was jointly agreed that an advance of 5s. per week should be paid to the men on the resumption of work, and that future general alterations in wages shall be dealt with in accordance with provisions for avoiding disputes, which shall be mutually agreed upon. It was also recommended that work shall be resumed not later than January 19. These recommendations have, however, to be balloted upon by the members of the moulders' unions, and from the results which had come to hand at the time of going to press it would appear premature to be too optimistic. We hope, however, that the men will see the great desirability from every point of view of returning to work without delay. It should be noted that the moulders' original demand was for an advance of 15s. a week for men and 7s. 6d. for boys. Since that date an award of 5s. a week advance has been made to the 18 other engineering unions by the Arbitration Court. The strike has apparently therefore produced nothing which could not have been gained by more legitimate means, and has at the same time undoubtedly caused widespread unrest and loss of trade. On the other hand the present struggle may be said to mark a turning point in the moulder's progress. No longer will he be content to occupy a position of secondary importance in the engineering world, for he at length realises his value as a craftsman, and intends to be treated as a craftsman. However the present struggle terminates, he will not rest content with a rise in wages alone. He has not endured the hardship of a five-month strike for the purpose of annexing a few extra shillings a week. His purpose is much higher, and it will be well for all who have the interests of the engineering industry at heart to recognise this. This attitude on the part of the moulder is not to be deplored, for it marks the awakening of a sense of responsibility —of self-respect, and that is what is needed in every phase of industrial life. Intelligence, self-confidence and proportionate reasoning are factors which produce the efficient worker, and react in a favourable manner upon the industry as a whole.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

Mr. A. Press contributes an article on page 35 on "Triode Amplifications and Detector Sensitivity," in which he discusses certain discrepancies in two of Capt. L. B. Turner's contributions to the Electrician on this subject, and points out that these appear to be due to the symbolism of partial differentiation employed.

On page 32 we give the first part of an account of "The Electrification of the Melbourne Suburban Railways" on the high-tension direct-current system. This has been carried out under the instructions of the Victorian Government, to designs of Messrs. Merz & McLellan.

On page 36 we conclude our account of a Paper on "Electricity in Tin Mines," read before the Institution of Electrical Engineers by Messrs. D. M. W. Hutchison and W. J. Wayte.

On page 40 we give an account of a Paper read before the North-Eastern Centre of the Institution of Electrical Engineers on "Electrical Development at Christchurch (N.Z.)," by Mr. J. Lythgoe.

Our Correspondence Columns (page 41) contain a letter by M. Marius Latour commenting on the fact that Prof. Fleming in his recent book on the "Thermionic Valve" does not mention any French engineer among those who have studied the question of the three-electrode valves. We also give Prof. Fleming's reply. Mr. R. C. Clinker states that the "Property of a Well-known Alternating-current Circuit" described by Mr. E. V. Brown on page 748 of our issue of December 26th was commented on some years ago in the Electrician. He is unable to give the reference.

Our Leading Article (page 43) deals with the necessity of the water-power available in this country being controlled by some independent body in order that the best use may be made of it for electric and other purposes. In this connection attention is called to the suggested developments in the Dundee district and on Dartmoor. Details of the latter scheme are given on page 44.

Some particulars af joint electricity authorities which are being formed under the Electricity Supply Act of 1919 are given on page 45.

Arrangements for the Week.

FRIDAY, Jan. 9th (to-day).

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W.1. Paper on "Goods Handling and Control," by Mr. C. H. Woodfield.

Electro-Harmonic Society.

8 p.m. At the Holborn Restaurant, London, W.C. Smoking Concert. Mr. L. L. Robinson, chairman.

SATURDAY, Jan. 10th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, London, W. Juvenile Lecture on "Sound in War," by Prof. W. H. Bragg, F.R.S. (Lecture VI.).

TUESDAY, Jan. 13th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, London, W. Lecture on "Modern Development of the Miner's Safety Lamp," by Sir John Cadman, K.C.M.G. (Lecture I.).

Institution of Civil Engineers.

5.30 p.m. At Great George-street, London, S.W. Papers on "Whitby Harbour Improvement," by Mr. J. Mitchell; "The Design of Harbours and Breakwaters with a View to the Reduction of Wave Action within Them," by Mr. R. F. Hindmarsh; "Wave Action in Harbour Areas, with Special Reference to Works for Reducing it at Blyth and Whitby Harbours," by Mr. J. W. Sandeman; and "The Improvement of the Entrance to Sunderland Harbour, with Reference to the Reduction of Wave Action," by Mr. W. Simpson.

Institution of Electrical Engineers North Midland Centre.

7 p.m. At Hotel Metropole, Leeds. Paper on "Large Power Transformers," by Mr. A. G. Ellis and Mr. J. L. Thompson.

Institution of Electrical Engineers—Scottish Centre.

7 p.m. At Princes-street Station Hotel, Edinburgh. Paper on "The Electrical Power Supply in the War Zone," by Major T. Rich, O.B.E.

Rontgen Society.

7 p.m. At the Royal Photographic Society's House, 35, Russell-square, London, W.C. Lecture on "Some Aspects of Radiology," by Major G. W. C. Kaye, O.B.E.

WEDNESDAY, Jan. 14th.

Royal Society of Arts.

3 p.m. At John-street, Adelphi, London, W.C. Juvenile Lecture on "Railways and Engines," by Mr. L. Pendred. (Lecture II.)

Institution of Electrical Engineers Wireless Sectional Meeting.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Wireless Direction and Position Finding," by Capt. H. J. Round.

Institution of Electrical Engineers South Midland Centre.

7 p.m. At the University, Edmund-street, Birmingham. Paper on "Eddy Current Losses in Stator Windings," by Mr. H. W. Taylor.

Association of Engineers-in-Charge.

7.30 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "Currency, Finance and Industrial Training," by Mr. T. E. Gregory.

THURSDAY, Jan. 15th.

Institution of Electrical Engieners—South Midland Centre.

7 p.m. At the University, Edmund-street, Birmingham. Joint Meeting with Midland Junior Gas Association for discussion on "The Uses of Gas and Electricity for Heating and Power."

FRIDAY, Jan. 16th.

Institution of Electrical Engineers—Students' Meeting.

7 p.m. At the City and Guilds (Eng.) College, South Kensington, London, S.W. Paper to be read on "The Development of Automatic Telephony," by Mr. J. H. Reyner.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Chairman's Address on "Meteorology and Engineering," by Mr B. E. Dunbar Kilburn.

Paisley Association of Electrical Engineers.

7.30 p.m. At the Technical College, George-street, Paisley. Paper on "Electricity and Matter," by Mr. A. M'Lean, B.Sc.

Royal Institution.

9 p.m. At Albemarle-street, Piccadilly, London, W. Discourse on "Low Temperature Studies," by Prof. Sir James Dewar, F.R.S.

The Electrification of the Melbourne Suburban Railways.

Interesting Application of the H.T. Direct-Current System.

GENERAL.

The railway system of the State of Victoria is operated by the State Government, the executive functions being exercised by Railway Commissioners, who are at present Mr. C. E. Norman, chairman, and Mr. W. M. Shannon. The scheme owes much of its success to the late Mr E. B. Jones, for some years a Commissioner, whose death before the completion of the work was a serious loss to the Victorian railways. The total track mileage of the railways is about 4,300, of which over 300 miles are suburban lines serving the city of Melbourne. The importance of the Melbourne suburban traffic to the whole system is shown by the fact that it accounts for some two-fifths of the total train mileage of the railways entering Melbourne. Not only are the suburban railways of greater importance to the system as a whole than in other countries, but they are of greater importance to the city itself than are the suburban systems of most other cities. Owing largely to the foresight of the authorities responsible for laying out the city, the density of population is only about one-fifth of that commonly found in this country. The result is that the suburban railways cover an unusually large area in spite of there being an excellent cable tramway, and deal with a large amount of traffic which in other cities is dealt with by electric tramways or interurban railroads, or motor omnibuses.

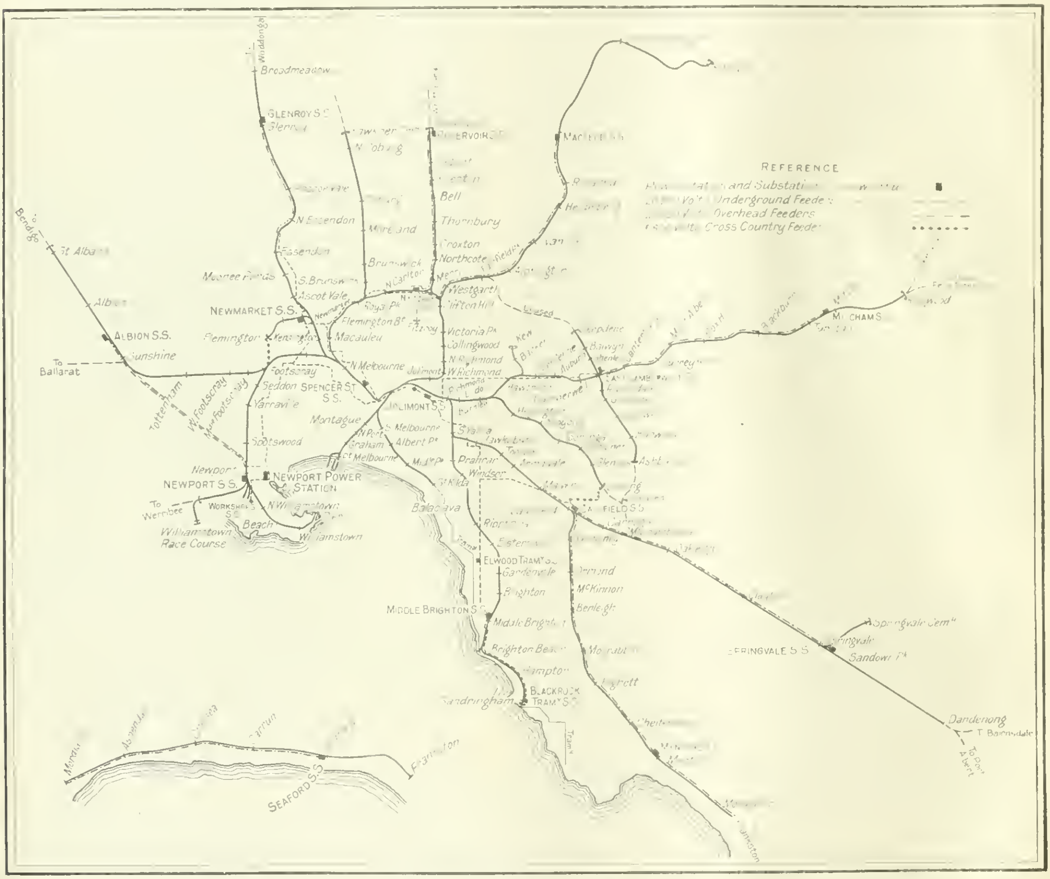

FIG. 1.—MAP OF THE MELBOURNE SUBURBAN RAILWAY SYSTEM, SHOWING ELECTRIFIED LINES, POSITION OF THE POWER STATION, SUBSTATIONS AND THE PROPOSED ROUTES OF THE 20,000-VOLT UNDERGROUND AND OVERHEAD FEEDERS.

THE CHOICE OF SYSTEM.

The question of converting the Melbourne suburban lines to electric traction was first considered in 1907, when, at the request of the Hon. Sir Thomas Tait, K.C.M.G., chairman of the Commissioners, Mr. Charles H. Merz, visited Melbourne, and presented an exhaustive report (in June, 1908) on the whole question.* This report showed that although there would be a considerable saving in operating expenses, an increase of traffic more than sufficient for the capital charges. An increase in traffic more than sufficient for this purpose was anticipated, but it was decided not then to proceed with the electrification. By 1912, however, the traffic had increased very much more than had been estimated and sufficiently to necessitate either expensive track widenings or alternatively to justify the capital expenditure involved in electrification except that this produced no additional traffic. At the request of the Hon. W. A. Watt, then Premier of the State of Victoria, a further report was presented by Messrs. Merz & McLellan based upon actual tenders from manufacturers. Alternative prices were obtained for the single phase and direct-current systems. The latter proved to be substantially cheaper both in capital expenditure and operation. Contracts were, therefore, placed providing for the conversion of the whole of the suburban lines on the high tension direct-current system, the work to be carried out in three stages. With the exception of the coach equipments, all the contracts have been executed by British or Australian firms, with the stipulation that manufacture of the British contracts was to be carried out in this country. The coach equipments were ordered in America, with the special condition that some of the motors were to be made in England. The scheme is one of the largest and most important railway electrification schemes as yet carried out. The leading engineering features are the production of electric power at 3,300 volts, between phases, by means of three-phase 25-cycle turbine-driven alternators. This is raised to 20,000 volts by static transformers, and transmitted to sub-stations, where it is converted to 1,500 volts direct current. At this pressure it is supplied to the trains by means of an overhead wire. The main contracts were placed in March, 1911; work started in November, 1913; and the first train was run on May 29, 1919. The work has, of course, been much delayed by the war. A map of the electrified lines is given in Fig. 1.

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* THE ELECTRICIAN, Vol. LXI., pp. 880, 919, 962.

of a building for containing machinery plant and simple, but the result is distinctly pleasing. Between the two boiler houses is a space occupied by a general purpose building containing stores, water storage tanks, workmen's accommodation, laboratories, test rooms, &c. Placing these accessories in this position is not only satisfactory from the architectural point of view, but has proved efficient as regards administration and working. The separation of the engine room from the boiler house by a lower pump room has a good effect, and the low symmetrically arranged chimneys are not an eyesore.

The Turbo-Generator Plant.

Each prime mover is treated, as far as possible, as an independent unit; thus each turbo-generator has its own oil-cooled step-up transformer for stepping-up to 20,000 volts, and a unit transformer stepping down to 440 volts for operating the circulating water pumps, oil cooler pumps, air filter pumps, &c. Although experience seems to indicate that oil in transformers presents a negligible fire risk, it was thought wise to instal the transformers belonging to each generator in a separate chamber outside the engine room. Being thus out of reach of the engine-room crane, special provision is made for lifting the transformers off to railway trucks. Between the transformer chambers are intervening chambers containing air filters, neutral resistances, &c. The whole of the condenser, boiler feed, transformer, air cooler, turbine oil cooler, and air filter auxiliaries are placed on the same level in the basement and easily accessible, the basement being well lighted and free from obstructions. The turbines (see Fig. 3) are of the Parsons pure reaction type, with divided cylinders, the high pressure portion being of the single flow type, the low pressure of the double flow type with central admission. The tandem type turbine, in large sizes, has advantages both as regards economy and manufacture; the cylinders are not exposed to such extreme ranges of temperature, and with double flow in the low pressure the length of the last few rows of exhaust blades can be kept down. A recent innovation is the absence of any rigid connection between the steam chest and turbine cylinder, thereby lessening the risk of undue stresses and allowing a more uniform mass of metal round the periphery than when the steam chest is actually mounted on the cylinder. The construction of the stator windings of the alternator is interesting. Cotton-covered stranded wires are laid up into an oval conductor the full area of the slot; each conductor is soldered to a flat copper and connection, thus simplifying the end connections and facilitating rigid anchoring. The Michell type thrust bearing — an Australian invention — is used throughout.

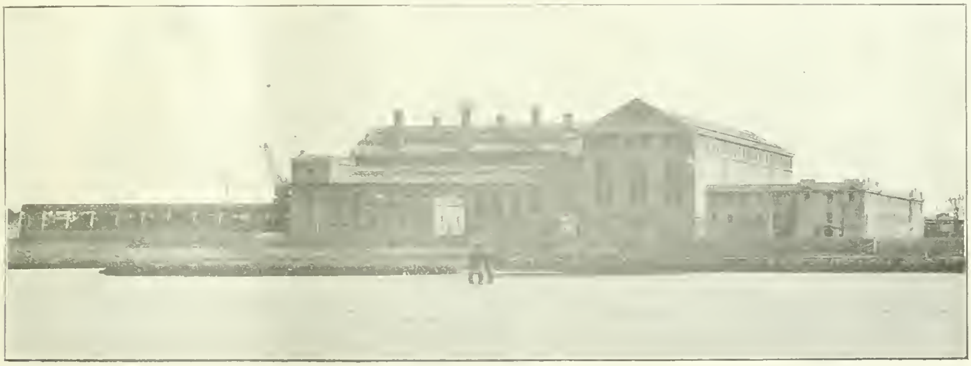

Fig. 2.—View of Newport Power Station from the River Yarra.

General Details of Power Station Plant.

The power station was originally to have been placed on the River Yarra, at Yarraville, the nearest available site to Melbourne having a good supply of condensing water and reasonable access by rail. While the detailed plans were being developed, however, it was found that the prospective harbour works might interfere with the existing course of the river, and reduce the quantity of condensing water to that required for the suburban railways only, leaving no future margin for additional power for other purposes. It was, therefore, decided to adopt a site at Newport, which had certain advantages in connection with condensing water, sub-soil, &c., which compensated for the additional expenditure on transmission cables. Thus the existence of a stone breakwater enabled the intake and discharge to be separated in a manner which is not ordinarily obtainable without considerable expense. The site consists of some 36 acres of land adjoining the Williamstown Ferry, and is mostly situated on basaltic rock, which, while providing a satisfactory foundation, involved considerable extra work, some 45,000 cubic yds. having to be removed. The site has been laid out to contain two power stations side by side. In this way full advantage may be taken of any future developments in power station design without interfering with the symmetry of the present station. The first station is laid out to contain six 10,000 kw. turbo-alternators, which suffices for present requirements, and allows two spare sets for the purpose of stand-by and overhaul. The two boiler houses are at right angles to the engine room, and are each provided with its own coal store and coal handling machinery. The elevation of the power station is shown in Fig. 2. It is necessarily a compromise between the expense of a purely architectural design and the inartistic nature

Coal and Water Supply.

The situation of the circulating pumps is a novel and convenient feature of the design. The water supply to the pumps is in duplicate, with an arrangement so that four pumps may be supplied from each half of the duplicate system. As this is sufficient for the full load output of the station, overhaul operations in connection with the maintenance and upkeep of the water supply system can be carried out at any time as a matter of routine. The boiler house is provided with suction ash plant, so that it is not necessary to remove the ashes by hand and tip them into railway wagons. This plant also deals with the soot from the economisers, an improvement upon the usual arrangement where are used small tipping wagons. The mechanical coal handling arrangements permit of the fuel, which is delivered in railway trucks, being deposited in the overhead bunkers of the boilers or in the coal stores or taken from the stores and delivered to the bunkers, no manual labour being employed. A luffing jib crane is provided for loading the coal into each coal store, and can deliver coal direct from the store to the boiler house conveyors without using the coal store conveyor. In short, the whole of the boiler house equipment has been laid out with special attention to the reduction of manual labour

The boilers are of the Babcock & Wilcox marine type fitted with Green's economisers. Twenty-four boilers are at present installed, each with a close-link chain grate stoker. The heating surface per boiler is 6,725 sq. ft. and the superheated surface 1,043 sq. ft. The grate area is 168 sq. ft., and the working pressure 210 lb. per sq. in., with 600 F. superheat.

An Interesting Design of Switch House.

One of the most interesting features of the installation is the switch house. This is built parallel to the engine room, but at some slight distance from it, there being no attempt to provide ready communication between the switch house and the engine room staff except by telephone and telegraph. The power station bus bars are divided into two sections by means of a section switch, each sub-station being fed from both sections. So far as security of supply is concerned, therefore, the arrangement may be regarded as equivalent to duplicate bus bars without the complication and expense of the latter. Another feature is the arrangement for preventing accidents, a system of mechanical interlocking being provided, which prevents all possibility of an operator obtaining access to conductors while they are alive This applies not only to the conductors of each switch panel, but to the sections of the bus bars themselves; that is to say, access to each section of the bus bars is entirely prevented until the whole of the isolating switches connected to it are open, thus ensuring that the bus bars are dead. In addition, each oil switch is interlocked with its isolating switches, so that the latter cannot be opened or closed while the oil switch is closed. The oil switches are, of course, electrically operated with remote control, the operating mechanism having a wall separating it from the oil switch chamber, so that it can be examined and cleaned without danger This switchgear was supplied by Messrs. Siemens Bros. Dynamo Works. An interesting feature is the absence of windows in the switch house. One side of each switch cell is open to the outside air in order immediately to release any excessive air pressures in the event of an unusually heavy short circuit. Precautions are, of course, taken to prevent trouble from birds, rain, &c.

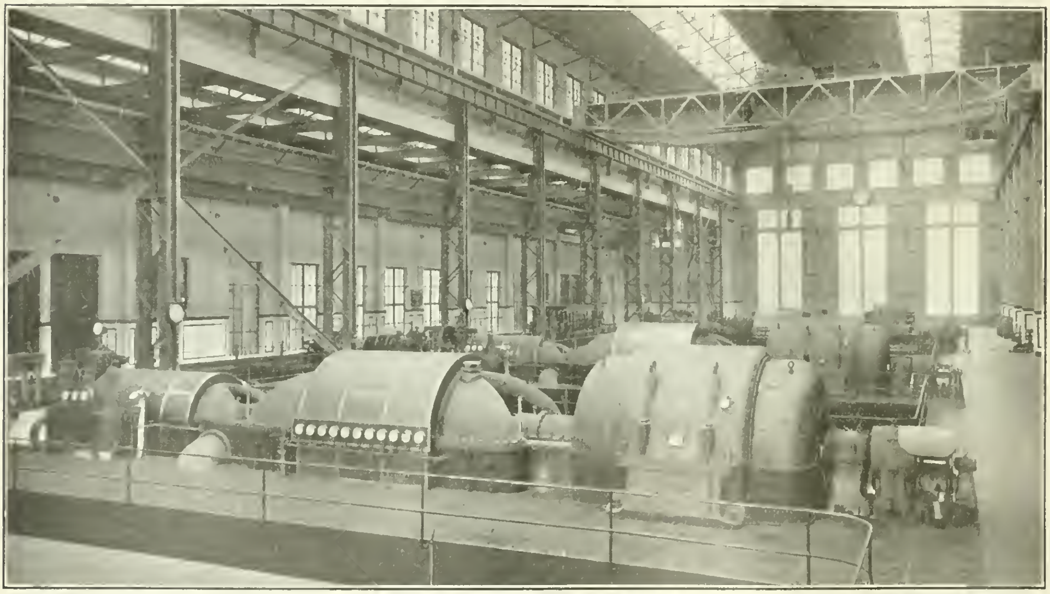

Fig. 3.—View in the Turbine Room at Newport Power Station.

Each phase of the main switches is a separate single-pole switch in its own oil tank, the parts working in air being isolated from the parts working in oil. Each single-pole switch has multiple breaks in series arranged vertically close together in the middle of the tank, with insulating barriers between adjacent breaks, there being four breaks in the single-pole generator oil switches. These are so connected that upon the switch opening under load the mutual induction of the arcs produces a radial blow-out effect towards the insulated well of the tank. Opening speeds up to an equivalent of 50 ft. per second can be obtained, aluminium being employed to ensure rapid acceleration. The gases produced are discharged to the outer passage way. The three-phase oil switch will safely open a short circuit on a system controlling power of a rated capacity of 240,000 kv. amperes. The operating gear consists of a rotary type magnet actuating a countershaft through a toggle mechanism and tripping box, the magnet being excited from a 110-volt battery supply and contactor, operated from the control board. In addition to red and green indicating lamps, there is an alarm bell device to give warning when the switch has opened. The generator equipments are fitted with Merz-Price protective gear, while feeder equipments have split conductor protective gear. Each generator has an emergency control pillar and load indicator fixed in the engine room.

Arrangement of Control Room.

The control room is situated at the end of the switch house. In it is centred not only the control of the main power station switches of the generators and transmission feeders, but all electrical operations throughout the entire transmission and conversion system are directed from this point. On the control engineer rests the responsibility of all electrical switching operations and his control is absolute. A gallery is provided for visitors' although there is little to attract the attention of the non-technical observer during operations. The most striking feature is a huge diagram covering one wall of the room showing the position of all principal switches on the system

(*To be continued.*)

Triode Amplifications and Detector Sensitivity.

By A. PRESS.

If one follows the course of the discussion of the I.R.E. for April, 1919, relative to triode constants, and then compare it with the work of Capt. L. B. TURNER, in THE ELECTRICIAN, London, for July 4, 1919, there will appear to be considerable confusion in the formulæ involved. The matter appears to hinge on proper regard to the symbolism of partial differentiation.

Capt. Turner has very kindly given us a set of curves, *see* Fig. 2 (taken from the above-mentioned Paper), which show that the plate current i_a is a function both of the grid potential v_g, as well as of the plate potential v_a. That is, we have

$$i_a=f(v_a, v_g). \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (1)$$

He has also given us a plot of the g and dg/dv_g functions. The latter are significant.

In a similar manner, though to a much smaller extent, it must follow that if i_g is the grid current,

$$i_g=\varphi(v_a, v_g). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

In the present Paper it is desired to evoke formulæ for the potential and current magnifications, as well as for the detector sensitivity G_m, dependent as it is on d^2i_a/dv_g^2.

Potential Magnification.—If the potential v_g is changed on the grid it necessarily follows that we have a change in the v_a of the plate. It will be found that two separate elements contribute to the change in plate potential. Necessarily, from the nature of the circuit, we have

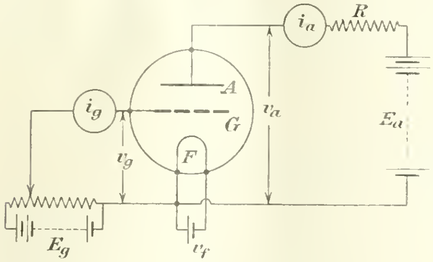

FIG. 1.

$$E_a=v_a-Ri_a\,;\quad v_a=-Ri_a+E_a. \qquad . \qquad (3)$$

Thus

$$\frac{dv_a}{dv_g}=-R\frac{di_a}{dv_g}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (4)$$

so long as E_a is a constant. It is the plate current i_a dependent as it is on the relation (1) that has the above two factors, for on differentiating we find

$$\frac{di_a}{dv_g}=\frac{\partial i_a}{\partial v_a}\cdot\frac{dv_a}{dv_g}+\frac{\partial i_a}{\partial v_g}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (5)$$

The first right-hand term contains the partial differential

$$\frac{\partial i_a}{\partial v_a}=\frac{1}{\Omega}. \quad . \quad . \quad . \quad . \quad . \quad . \qquad (6)$$

which interpreted implies that the internal plate-filament resistance Ω is determined with the grid potential v_g kept constant. It is the second term

$$\frac{\partial i_a}{\partial v_g}=g \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (7)$$

that assumes the mutual conductance g of Prof. Hazeltine as measured with the plate potential kept constant. This will be of importance when we come to consider the detector sensitivity, for it will be shown that in reality a correcting factor will have to be introduced to obtain the former.

From (5) we see that any variation of plate current i_a, affecting as it must the plate potential v_a, is made up of two components. The one is a plate current component $\partial i_a/\partial v_a$ on the basis that the grid potential is held constant. The second current component is due to a change of grid potential v_g on the understanding that the plate potential v_a is held constant. Both of these components have to be introduced into (4) to find the total change of v_a with respect to v_g.

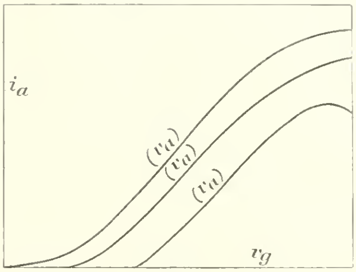

FIG. 2.

Making the necessary substitutions, we find on introducing (5) in (4)

$$\frac{dv_a}{dv_g}=-\frac{R}{\Omega}\cdot\frac{dv_a}{dv_g}-Rg$$

$$\frac{dv_a}{dv_g}=\frac{-Rg}{1+R/\Omega}=-\frac{R\dfrac{\partial i_a}{\partial v_g}}{1+R\dfrac{\partial i_a}{\partial v_a}}. \quad . \quad . \quad . \quad . \quad . \qquad (8)$$

From inspection it should be clear in the general case that g and Ω are not strictly constants. They both depend on partial differentiations.

Current Amplification.—Differentiating (1) with regard to i_g we have

$$\frac{di_a}{di_g}=\frac{\partial i_a}{\partial v_a}\cdot\frac{dv_a}{di_g}+\frac{\partial i_a}{\partial v_g}\cdot\frac{dv_g}{di_g}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (9)$$

Again, two components appear. To find the factor dv_a/di_g resort must be had to (3). Thus

$$\frac{dv_a}{di_g}=-R\frac{di_a}{di_g}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (10)$$

and (9) becomes

$$\frac{di_a}{di_g}(1+R/\Omega)=g\frac{dv_g}{di_g}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (11)$$

The right hand term has therefore to be evaluated.

Turning to equation (2),

$$\frac{di_g}{dv_g}=\frac{\partial i_g}{\partial v_a}\cdot\frac{dv_a}{dv_g}+\frac{\partial i_g}{\partial v_g}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (12)$$

The extreme right-hand term can be said to measure the internal resistance ω from grid to filament on the understanding that the plate potential v_a is kept constant. Thus, making use of (8), and setting

$$\frac{\partial i_g}{\partial v_g}=\frac{1}{\omega};\quad\frac{\partial i_g}{\partial v_a}=g', \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (13)$$

$$\frac{di_g}{dv_g}=-\frac{Rgg'}{1+R/\Omega}+\frac{1}{\omega}=\frac{1+R/\Omega-R\omega gg'}{\omega(1+R/\Omega)}, \quad . \quad . \qquad (14)$$

the evaluation of (11) follows, and we have

$$\frac{di_a}{di_g}=\frac{g\omega}{1+R/\Omega-R\omega gg'}. \quad . \quad . \quad . \quad . \quad . \quad . \qquad (15)$$

It is the mutual conductance quantity g' that can be designated as the conjugate conductance, and is much smaller than $g=\partial i_a/\partial v_g$.

Triode Detector Sensitivity.—A small change in grid potential dv_g produces a total change in the plate current. The possibility for detection of any setting of the triode will therefore be determined by a study of the function

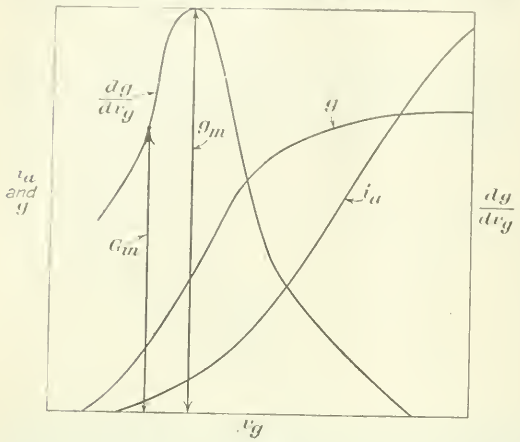

FIG. 3

$$\frac{di_a}{dv_g} = G. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

This quantity G, however, must not be confounded with the usual mutual conductance value (7) derived by keeping v_a constant. When the triode is left to itself under the influence of the battery E_a, and resistance R, v_a can only approximate to constancy. A correction factor is, therefore, to be expected for the usually derived formula, and will account for the adjustment referred to by Capt. Turner with regard to Fig. 6 of his Paper, reproduced here as Fig. 3. Substituting from (8), (13) and (7) we have for (5)

$$\frac{di_a}{dv_g} = \frac{\partial i_a}{\partial v_a} \cdot \frac{dv_a}{dv_g} + \frac{\partial i_a}{\partial v_g}, \quad . \quad . \quad . \quad (17)$$

$$\frac{di}{dv_g} = \frac{R_a}{\Omega} \cdot \frac{1}{1+R\Omega} \cdot g = \frac{g}{1+R\Omega} = G. \quad . \quad (18)$$

It is the quantity G, therefore, and not g that rightly leads to a study of the detector value. For *maximum possible detector sensitivity*, we need a value G_m, satisfying the relation

$$\frac{d}{dv_g}(G) = \frac{d}{dv_g}\left(\frac{di_a}{dv_g}\right) = \frac{d^2 i_a}{dv_g^2} = 0. \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

Compare in this regard Capt. Turner's curve dg/dv_g (*see* Fig. 3 herewith).

It is only when R in (17) is negligible in comparison with the plate resistance that we have

$$\frac{d^2 i_a}{dv_g^2} = \frac{dg}{dv_g}.$$

Under the circumstances a close approximation by (18) is

$$G_m = \frac{1}{1+R\Omega} \cdot g_m. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

The optimum or G_m value is, therefore, always smaller than g_m. It is submitted that the designation detector sensitivity should be made to refer to G_m, and not to the second derivative dG/dv_g, which is zero for maximum detection value.

Electricity in Tin Mining.*

By D. M. W. HUTCHISON, B.Sc. and W. J. WAYTE.

(*Concluded from page 10.*)

In the second part of the Paper the authors give a detailed description of four typical electrical mining plants where the different methods dealt with in the first part of the Paper are employed, and then go on to make certain recommendations regarding the design of electrical apparatus which it is intended to use in the Federated Malay States. Standard designs must be modified owing to the moisture and heat of the climate and to the tropical rainfall.

STANDARDS RECOMMENDED.†

Generator pressures—Alternating current: 440, 550 and 2,200 volts. *Direct current:* 115, 240, 460 and 550 volts. It is not advisable to generate at a higher pressure than 2,200 volts owing to the rapid deterioration of insulating materials due to the moisture-laden atmosphere.

Pressure at high-tension terminals of step-up transformers.—2,200, 3,300, 6,600 and 11,000 volts. So far, 11,000 volts is the highest pressure in use, but there is no particular reason why higher voltages should not be used if necessary at any rate, up to 20,000 volts. For higher voltages, special precautions on account of the dampness of the atmosphere would probably be necessary.

Pressures on motor or consumers' terminals.—Alternating current: 100, 230, 400, and 500 volts. *Direct current:* 110, 230, 440, and 500 volts. *Frequency:* 50 periods. For new installations, the authors recommend a voltage of 400 at motor terminals for a three-phase alternating-current system. This is the most usual voltage, and its adoption would facilitate linking up and encourage local agents to keep stocks.

Tests and temperature rises.—It is a common sight to see motors which have been rated on the assumption that they would be used in a temperate climate working continuously up to their full load as marked on the name plate, and even at overloads; this accounts to a great extent for the large amount of re-winding that has to be done. The temperature of the air should be taken as 95 F. under cover, and the following temperature rises should not be exceeded: (*a*) Generators and open and protected-type motors after six hours' run at full load, 63 F.; (*b*) motors driving intermittent loads (winches for instance) after one hour's run at full load, 70 F.; (*c*) enclosed and pipe-ventilated motors are seldom used, and tests prescribed should be drawn up to suit each special case; (*d*) oil-cooled transformers, maximum temperature of oil not to exceed 170 F. at continuous full load; (*e*) all standards and tests other than the above to be in accordance with British standards as recognised by the Institution, allowing for the higher temperature of the air. It may be considered that the temperature rises for generators and motors are on the low side; but in a country where facilities for re-winding are doubtful, and where motors are often put to work for which they were never originally intended, it is as well to be on the safe side, even if it costs a little more.

SPECIFICATION OF MACHINERY FOR THE FEDERATED MALAY STATES.

Boilers.—The water-tube type is most suitable. These have been so far always set in brickwork, but the use of the marine type with steel casing would probably be an advantage, as neither material nor labour for brickwork is good. To keep the number of spares a minimum, a type using one length of tube only is advisable.

Mechanical Stokers.—The type of coal used as a rule, "Rawang smalls," is very suitable for firing on chain grates. A short steel stack with induced draft is the best arrangement.

Coal-handling Plant.—It is not possible to store Rawang coal for any length of time, as it fires, so the arrangement made should aim at a steady continuous supply from truck to stoker hopper; the experiment of storage under water will probably be tried in the near future, but it is doubtful if this class of coal is suitable.

Prime Movers.—Turbines are being used for plants of 500 kw. and over. There are no special considerations, except that larger condensers will be required than in England, as the temperature of the

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* Abstract of a Paper read before the Institution of Electrical Engineers.

† British standards are recommended in all cases, except as regards the voltage of 230; this voltage is in universal use in the Federated Malay States and Straits Settlements, and there seems no sufficient reason to abandon it.

Table IV.—*French Mine Kampar 1917 and 1918.*

Year	Mine.	Gravel Pumps. Average work done. Lift, ft.	Gravel Pumps. Average work done. Water c. ft. per min.	Gravel Pumps. Average work done. Gravel c. ft. per min	Gravel Pumps. Hours run. No. I.	Gravel Pumps. Hours run. No. II.	Gravel Pumps. Average for pumps I. and II. Units per hour.	Gravel Pumps. Average for pumps I. and II. Effy. per cent.	Tailings Pumps. Average work done. Lift, ft.	Tailings Pumps. Average work done. Water c. ft. per min.	Tailings Pumps. Average work done. Tailings c. ft. per min	Tailings Pumps. Hours run. No. III	Tailings Pumps. Hours run. No. IV.	Tailings Pumps. Average for Pumps III. and IV. Units per hour.	Tailings Pumps. Average for Pumps III. and IV. Effy. per cent	Nozzle Pumps. Average work done. Lift ft.	Nozzle Pumps. Average work done. Kinetic pres. head ft.	Nozzle Pumps. Average work done. Water c. ft. per min.	Nozzle Pumps. Hours run. No. V.	Nozzle Pumps. Hours run. No. VI.	Nozzle Pumps. Average for Pumps V. and VI. Units per hr.	Nozzle Pumps. Average for Pumps V. and VI. Effy. per cent	Cost Data, &c. Workings costs at mine in cents. Power per unit.	Cost Data, &c. Workings costs at mine in cents. Power per cub. yd	Cost Data, &c. Workings costs at mine in cents. Total per cub yd.	Cost Data, &c. Cub. yards moved.	
1917	No. 2	78	234	11·95	7,762	. .	80·0	37·7								. .	80	202	7,762		35·0	76·[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1 10-in. gravel pump 480 r.p.m. 145 B.H.P. motor direct drive. Monitor pump 950 r.p.m. 75 B.H.P. motor direct drive.
1917	No. 3	78	234	11·06	7,892	. .	110·0*	38·7*	24	234	11·06	7,892					80	202	7,892	. .	40·27	66·5	1·96	12·70	30·42	194,000	10-in. gravel pump 480 r.p.m. 145 B.H.P. motor direct drive. Monitor pump 950 r.p.m. 75 B.H.P. motor direct drive. 8-in. tailings pump 360 r.p.m. 80 B.H.P. motor direct drive.
Jan. to June, 1918	No. 3	81	234	11·4	2,920	. .	80·0	42·4	24	234	11·4	2,920	. .	33·0	30·4	. .	60	202	2,920	. .	38·9	51·5	2·12	13·26	34·65	74,000	
July to Dec., 1918	No. 3	81	234	12·0	3,500	2,610	80·6	42·2	41	234	12·0	3,560	2,610	48·7	35·3	. .	60	211·5	3,560	2,610	40·6	51·7	2·12	13·26	34·65	164,500	2 10-in. gravel pumps 480 r.p.m. 145 B.H.P. motor direct drive. 2 monitor pumps 950 r.p.m. 75 B.H.P. motor direct drive. 1 10-in. tailings pump 360 r.p.m. 80 B.H.P. motor direct drive. 1 8-in. tailings pump 475 r.p.m. 75 B.H.P. belt drive.

Efficiency averages: Gravel and tailings pumps 37·8 per cent. Nozzle pumps 61·55 per cent. Motor efficiency is assumed to be 85 per cent in all cases.

* Units per hour for one gravel and one tailings pump and efficiency average for the two pumps.

cooling water will be about 86 F. to 90 F. if water is returned from a cooling pond.

Alternators.—Subject to reduced temperature rises British standard practice gives every satisfaction.

Switchgear.—For high pressures the most suitable is the totally-enclosed ironclad sliding-carriage type. It must be insect and lizard proof, all ventilating holes should be covered with fine gauge wire netting and all instruments should be enclosed. For low and medium pressures, the ordinary marble-panel central-station type is quite satisfactory. Here, again, precautions must be taken to prevent the entry of various small insects, especially into instruments. Where step-up transformers are used the isolating switches, and oil switches if used, on the high-tension side may be placed in cubicles near the transformer in order to shorten the length of the bare wiring, the oil switches being worked by levers from the main switchboard.

Cables and Connections in Power House.—For high pressures, multicore paper-insulated lead-sheathed armoured cable should be used, and must be properly sealed and divided at the terminals. The dividing boxes at the switchboard end should be incorporated in the switch panel. For low and medium pressures, rubber-insulated cables may be used.

Transformers.—If earth shields between primary and secondary windings are not provided, provision should be made for earthing the neutral of the low-tension winding. In view of the difficulty of drying out transformer windings after they have been immersed in oil, it is recommended that moderate sizes should be shipped in oil from the factory. Air-cooled transformers are not desirable.

Transmission Lines.—The range of temperature experienced varies between 60°F. and 130°F., and, as there is no ice or snow to contend with, a lower factor of safety can be used than that specified by the Board of Trade, but it is not usually necessary. The height of lines must not be less than 22 ft., so that steel poles are advisable, wooden poles of the necessary length being expensive and hard to obtain. Where cast-iron bases are used, the steel tube should pass through this to the bottom of the cast-iron base, and the cast iron should not be relied on to take the strain. With steel poles an earth wire is essential.

Lightning Protection.—At certain periods of the year thunderstorms are of frequent occurrence, and lightning is very severe in some localities. Various types of arresters are used, but the authors are of opinion that protection for overhead lines can best be obtained by (1) the use of step-up and step-down transformers for all but very short lines and by heavily reinforcing the insulation of the transformer coils nearest to the line, in conjunction with arresters of the horn type with carbon resistance in series with the earthed horn, or with electrolytic arresters. (2) An earth wire above the power wires earthed at frequent intervals. (3) Earthing the neutral point of the generator and step-down transformer on the low-tension side. It is a striking fact that, in no case within the authors' knowledge where step-up and step-down oil-cooled transformers have been used, has damage by lightning been experienced other than to the line; on the other hand, in those plants where air-cooled transformers have been used, or the generators have been connected direct to the line, failures of transformers, switchboard instruments and generators have invariably occurred even where earthwires have been used.

Lighting Circuits.—A voltage of 230 must not be exceeded, and this may best be obtained from a small transformer, single or three phase; if single phase, the centre point of the winding should be earthed; if three phase, the neutral point. The voltage between any two wires should not exceed 230. There have been several fatalities due to shock on alternating-current lighting circuits where the potential to earth was 230 or over.

Mine Distribution.—This is invariably by overhead wires on hard wood pole lines, the minimum height being nominally 18 ft. The motors are usually placed in temporary sheds, and connections between lines and switchgear are made by rubber cables, bare wires not being allowed within 7 ft. of any building. Rubber insulation lasts about 18 months if exposed to the weather, but so far no satisfactory substitute has been found to replace it; probably three-core rubber-insulated armoured cable would last longer, as the rubber would be shielded from the direct rays of the sun. Where high-pressure leads enter a temporary building a three-core paper-insulated lead-sheathed armoured cable with proper terminal boxes and bonding appliances is called for.

Mine Switchgear.—The only type that can be called safe is the totally-enclosed interlocked ironclad type. It is now so moderate in price that there is no excuse for the employment of any other. In the past, makers have supplied totally unsuitable switchgear chiefly bare knife switches and bare fuses mounted on heavy marble panels. This apparatus was often to be found unfenced over a wet floor and under the charge of a barefooted coolie. No-voltage and overload releases should be fitted in all cases. All iron work and motor frames must be earthed, and usually this means an earth plate to every motor.

Mine Motors. Motors wound for voltages above 500 are not necessary for the majority of mining work, and, except in large sizes, are undesirable. Former-wound stator coils should be used in preference to hand winding. With semi-closed slots it has been found that coils of the "cut and push through" type are the most satisfactory. The slot insulation of all former-wound coils should be of mica moulded on to the coil after winding, the coil being treated under vacuum with suitable impregnating solution before being placed in position in the slot. Trouble with hand-wound coils has been frequently experienced, more especially in high-voltage motors, due to the difficulty of packing the wires tightly inside the slot and excluding air. Manufacturers also frequently wind the coils so that the end turns are adjacent and have to withstand the full voltage of the coil. Where speed regulation is specified, brushes and slip-rings should be of liberal design, and the latter should be well spaced to prevent short-circuits in starting. The most satisfactory type of resistance is the cast-iron grid, trouble having been experienced with liquid resistances. The connections between switch panel and starter and between rotor and resistances are best made by three-core armoured cable equipped with sealing boxes; but single-core rubber-insulated cable, if properly protected, is quite satisfactory for medium pressures.

Winches. The usual duty required of a winch is to haul loads of three or more trucks containing about ¾ yd. of karang up an incline, which varies in length and grade, at the rate of about 12 trips an hour, the ascending trucks being partly balanced by the descending empties. The conditions vary in different mines, and must be specified in each case. The winch should be of the double-drum variety, with motor, resistances, switches and tramway-type controller mounted on a bedplate of structural steel, the whole arrangement being as portable as is consistent with strength.

The best arrangement is to mount driving spur wheel and band brake between the drums; this, without unduly increasing the width of the winch, gives the drums a wider pitch. The pitch of the rails is usually from 4 ft. 6 in. to 6 ft. 6 in., and a drum pitch of 3 ft. 9 in. gives good results. If the pitch is too narrow the turns on the drum ride over one another, and cause undue wear to the ropes, besides danger of sudden jerks to the rope. One of the drums should be capable of rotation about the shaft when necessary for adjustment of the ropes, and this is usually effected by means of a clutch. One band brake held off by the driver's foot is sufficient in most cases. Electric braking has not been a great success and is generally unnecessary.

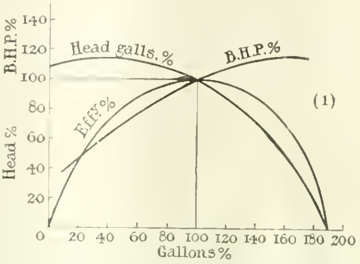
Puddler Drives. A puddler drive presents a fluctuating load. In the case of a single high-speed puddler, the normal power absorbed is about 12 B.H.P., which rises to 24 whenever a load of karang is dumped, and continues at that point for about one minute. As a high-speed puddler runs at 120 revs. per min., it is usual to employ a single-reduction back-geared motor in conjunction with a belt drive, a flywheel being generally used to help the motor at the moment the karang is dumped. Gears should run in an oil bath, otherwise, owing to the dust and grit which is always about, they become intolerably noisy. Low-speed puddlers run at about 5 to 9 revs. per min., and the power absorbed is about 8 to 13 B.H.P. per puddler. They are generally run in groups of two, and, being larger and having a great inertia, the fluctuations of current are not so great.

Pumps. A whole treatise might be written on the subject of the use and abuse of pumps in mining. The centrifugal pump is invariably used, and wisely so, as the water pumped contains certain quantities of grit in all cases. Unfortunately, it is almost impossible to place a pump and continue to work it for any length of time where it can show its best performance; sooner or later it will be put to work at an unsuitable head. The number of units wasted by the use of centrifugal pumps under unsuitable conditions must be enormous. Purchasers of pumps should obtain characteristic curves for each pump they purchase; these will be supplied gladly by first-class makers. These curves should be of the nature of the set in Fig. 4, and with this information the effect of variations of speed, head and quantity can be forecasted and the pump run under the most favourable conditions. Without this information, however, one can only guess. Where speed variation is necessary with three-phase motors, this, if moderate, may be obtained by the use of rotor resistances; but, if a larger variation is required, a belt drive is generally adopted.

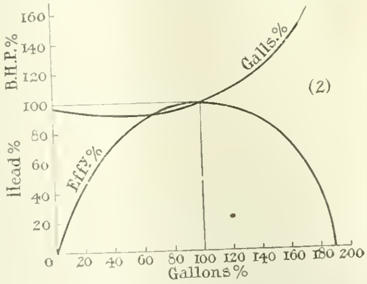
SPECIFICATION OF ELECTRICALLY-DRIVEN BUCKET DREDGES.

Cables.—The cables for connecting the dredge to the shore calls for special features; it must be flexible, mechanically strong, impregnable to moisture and continual change of conditions, since it is alternately immersed in water and exposed to the sun. It should also be as light as possible. The type of cable used on the Tin Bentong dredge has been found satisfactory over a period of two years. The armouring of this cable, however, shows signs of corrosion, and the authors therefore recommend that armouring should be heavily galvanised and covered with a protective compounded braiding.

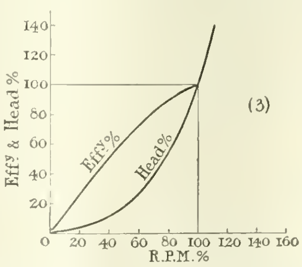
The cables for connecting the motors to the low-tension switchboard should comply with the following specification: The cables to be three core, each core with one wrapping of paper covered with four tapes of varnished cambric, the cores being laid together and served with compounded jute, covered with a layer of varnished cambric and braided overall. The motor cables should be run in piping clamped to the framing of the dredge.



Constant-speed curve showing approximate variation in quantity for a variable head in per cent of the normal.



Constant-head curve showing approximate variation in quantity for a variable speed in per cent of the normal.



Constant-quantity curve showing approximate variation in head for a variable speed in per cent of the normal.

Fig. 4.

Motors. All motors should be designed for a working voltage of 400. The bucket line motor has the most exacting duty of any to perform, since it is liable to sudden shocks and overloads caused by the buckets coming into contact with limestone pinnacles, clay banks or submerged timber. It must be reversible, and capable of running slowly at light loads to permit of inspection and repairs to buckets. The speed regulator can be of the grid or liquid type; the former will probably be found more suitable in practice, as clean water is not always obtainable from the dredge pond. The remaining motors of the dredge equipment call for no special features; they must all be of the protected type, drip proof and capable of carrying their rated full load with a rise in temperature not exceeding 63° F. with continuous operation. The horse-power of the motors required varies considerably according to the nature of ground treated, size of buckets and digging depth. The aggregate capacity of motors installed for a dredge capable of treating 75,000 cubic yards of solid per month at a depth of 50 ft. would be approximately 300 B.H.P. The digging capacity of dredges now installed in the Federated Malay States varies from 70,000 to 120,000 cubic yards per month. The total consumption of power per cubic yard treated for a moderate sized dredge would be approximately 1·7 kw.-hours. The authors are of opinion that for a group of electrically-driven dredges there would be a saving of £100 per dredge per month over a steam-driven dredge.

LODE MINING.

Lode and alluvial mining present entirely different problems, and when, as at present, tin of greater purity can be won were easily in alluvial workings there is not much likelihood of great efforts being made to develop lode mides where the rock has to be blasted out and crushed under stamps in order to bring it approximately to the state in which it is found in alluvial workings. The Government of the Federated Malay States recognise the greater difficulty of lode working by granting a rebate in certain cases on tin ore produced by this means. In the future, however, when the alluvial deposits have been turned over and over by processes of increasing efficiency until their valuable contents have been exhausted, a time will come when lode mining will receive more attention.

There are only about half a dozen mines of any importance coming under this category in the Federated Malay States, two of them very small, but another, Pahang Consolidated, the largest producer in the F.M.S., and probably the second largest in the world. In nearly all these mines electricity is in use to some extent, and its use is being extended, and as lode mining on anything but a very small scale is sure to be carried out by European companies in future, we may look forward to the time when there will be a fairly heavy demand for electrical power from this source. The engineering problems in lode mining need not be discussed at length, as they are practically similar to those encountered in gold mining. Power is required underground for pumping, hauling and drilling, and on the surface for driving rock crushers, stamps, tables and other tin-dressing machinery.

The Dagenham Works of the Sterling Telephone and Electric Company.

We have recently had the opportunity of inspecting the works of the Sterling Electric & Telephone Company at Dagenham. These works were erected in 1909 for the manufacture of telephone equipment and similar small current apparatus, and to deal generally with the output of the firm which before the war was increasing in a satisfactory way. With the outbreak of war the works were taken over by the Government, with the result that the output of the firm's specialities practically ceased, and instead the various machines and equipment installed were devoted to the manufacture of munitions of war of various kinds. So successful were the works in dealing with this class of output that it became necessary to extend them largely in order that the increasing demands for the class of work carried on there might be satisfactorily made. This success was largely due to the excellent way in which they were laid out and to the arrangements made for passing the material through the various processes of manufacture in the most expeditious way possible. The work of which we have just been speaking, of course, was done under Government sanction and supervision. With the coming of the Armistice the largely extended works were handed back to the company, and they were left to return to their peacetime avocations as best they could. We are glad to learn that this re-transformation has been satisfactorily achieved, and that, far from the extensions being a white elephant, the Sterling Company are even now considering further large schemes of rebuilding; and when we visited the works the other day we found them all in full swing, turning out telephone apparatus, indicators, bells, &c., at the highest possible rate of output. Fortunately for them, the moulders' strike has affected them much less than works dealing with larger apparatus.

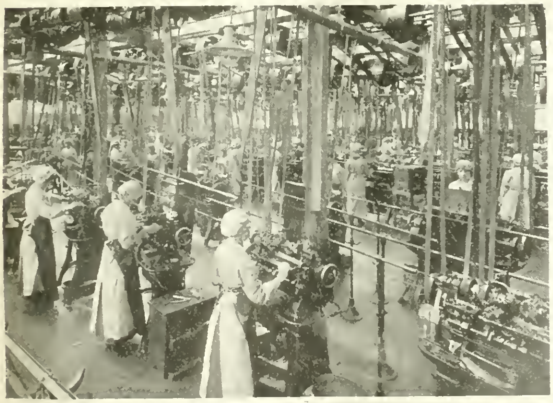


FIG. 1.—AUTOMATIC TURRET SECTION OF MAIN MACHINE SHOP.

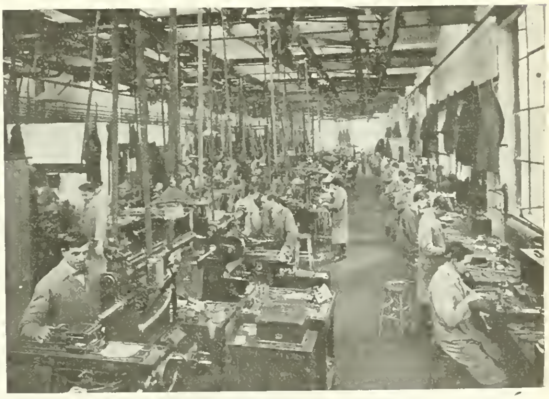


FIG. 2.—THE TOOL MAKING SHOP.

In the Sterling works mass production has been taken up very seriously with the most satisfactory results. A large drawing office and tool shop are kept constantly employed on the design and production of jigs, presses and other tools of special design for the production of various telephone parts and other apparatus produced by the firm. Great attention is paid to the accuracy of the work, and a very constant and close system of inspection has been inaugurated, so that no part passes to the assembly bench without it being certain that it is quite fitted to take its proper part in the general scheme of things. The illustrations, which we reproduce herewith, give a good idea of the way in which the works are laid out. All the machines are, of course, electrically driven, current being supplied from a generating station installed in the works itself. The shops are well arranged and adequately lighted, and in case it should be thought from the photographs that a forest of belts interferes with the work in any way, we may say that this is one of the cases where, if the camera does not exactly lie, at any rate to some extent it prevaricates.

In these days one of the most essential parts of any works if the production is to be of that high character and quality which is required by modern conditions, it is necessary that proper supervision should be made for the welfare of the workers generally. And one of the difficulties at Dagenham is the accommodation for the workers. At present they have to come by train from Barking or other east-end suburbs, which means a longer journey, and the Sterling Company have even had to provide motor conveyance between the works and Romford for the benefit of the workers living in that district. We understand that the Company have, however, obtained a site of about 18 acres on which to build dwellings for their employees closely contiguous to the works. This will enable a large number of good character houses to be erected and will at the same time leave room for future extensions both of the works and of the Garden City, which will then become a living entity. As we have already indicated, the necessity for the employees being given some means of recreation even during business hours has not been forgotten. A large adequately equipped kitchen is a feature of the works and adjacent to it are two canteens, one for the men and one for the women, in which excellent meals can be obtained at a very low rate. In addition to this a recreation hall in which theatricals, entertainments, concerts and dances can be given is also provided. Dancing, indeed, seems to be part of the general curriculum of the works, as during our visit a good portion of the dinner hour was taken up, especially by the feminine portion of the establishment, in going through the movements of the latest jazzes and other terpischorean recreations which we do not pretend to understand. The musical talent in the works is also very high and we also heard good accounts of the prowess of the various football teams.

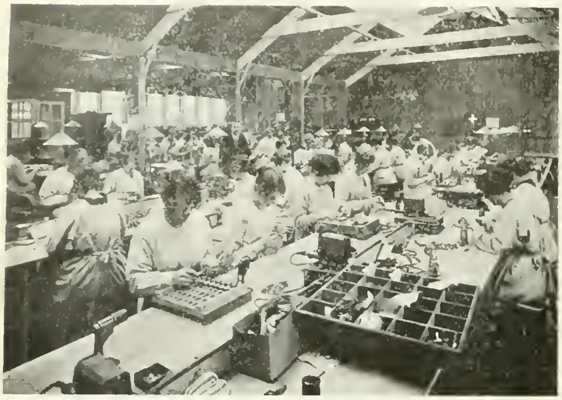


Fig. 3.—The Coil Winding Department.

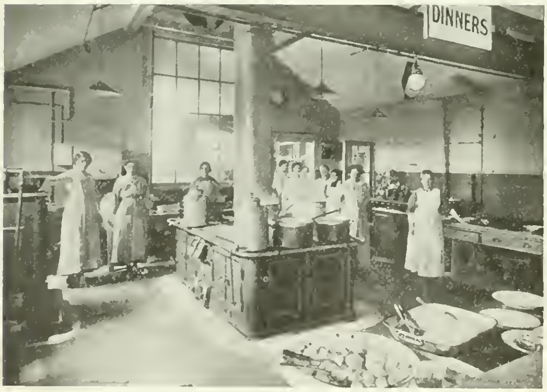


Fig. 4.—View of the Canteen Kitchen.

Our thanks are due to Mr. Guy Burney, the managing director of the Sterling Telephone & Electric Company, for giving us an opportunity of inspecting these interesting works.

Electrical Developments at Christchurch, N.Z.

At a recent meeting of the North-Eastern Territorial Centre of the Institution of Electrical Engineers a lecture was delivered by Mr. J. Lythgoe on "Electrical Developments at Christchurch, New Zealand."

In his opening remarks Mr. Lythgoe dealt briefly with the proposed hydro-electric schemes which will be undertaken by the Government, and on one of which the Arapuni scheme of 96,000 h.p., in the North Island the preliminary work is already being carried out. Mr. Lythgoe said that New Zealand is rich in water power, and in spite of its small population of 1,250,000, electricity supply is a subject in which the public take a keen interest. In the Government schemes a frequency of 50 cycles is being standardised, with transmission pressures of 100,000, 20·000, 10,500 and 3,000 volts and low tension pressures of 400 volts 3-phase and 230 volts single-phase.

The City Council of Christchurch is supplied from the Lake Coleridge scheme, which has been in operation about five years, the power house being approximately 70 miles due west of Christchurch. Lake Coleridge has an area of 13 square miles, and is about 1,700 ft. above sea level. The intake to the pipeline is 12 ft. 6 in. below the surface of the lake, and is provided with a protection wall to prevent silting up. The water is lead through a tunnel under the hill at the lake side to a surge chamber. The total fall through the tunnel is 7 ft. From the surge chamber the water passes to the power house through steel pipes 52 in. in diameter and 2,480 long. The working head is 480 ft. and each pipe is capable of supplying 3,000 kw. There is provision for extra pipes. The pipe lines are controlled by gates electrically operated from the power house.

Power House Details.

The power house is a ferro-concrete building 180 ft. long by 70 ft. wide by 40 ft. high, designed to accommodate 12,000 kw. of plant. It is equipped with Francis turbines, driving generators of British manufacture, supplying three-phase current at 50 cycles 6,600 volts, the units being of 1,500 kw. capacity. The transmission voltage is 66,000 volts, the step-up transformers being of American manufacture. There are two banks each consisting of three 1,500 kw. single-phase transformers, oil immersed and water cooled. The L.T. switchgear is of British make, the E.H.T. side is American. Reactances in series with the line are employed. The E.H.T. lines leave the power house through the roof and consist of 7/0·135 sq. in. aluminium wires per phase spaced 10 ft. apart in delta formation and transposed at two points on the line. There are two independent lines diverging from each other, and the spacing of the poles is 6 chains on level ground. This is varied to suit the nature of the ground, but there is one span as much as 20 chains with H poles at either end, which has given no trouble.

Electrolytic lighting aresters are used which are charged at regular intervals by the staff by means of specially designed horn switches, and they are also equipped with clock recording charts, which record end discharges. All the transformer oil is periodically pumped through an oil drying and refining outfit.

Supply Requirements at Christchurch.

The city of Christchurch is laid out in squares and has a population of 75,000. In addition to the city supply is also given to the suburbs of Spreydon, Riccarton, New Brighton and Wainairai, and to the Council destructor plant, baths, water supply plant and drainage pumping. The duties of the electrical engineer are somewhat far reaching, and have included the development of electolytic alkali, carbide and oxygen processes, which have now been taken over by companies, who, of course, are consumers. The City Council show rooms and the offices of the electrical works are housed in a separate building, the electricity department being an entirely separate and distinct undertaking, having its own accountancy department. A room is provided upstairs in which lectures can be given to employees of the electricity department and electrical contractors, and dances and social evenings can be held,

Street Lighting.

Street lighting is carried out on the series system, using constant current transformers. Two thousand street lamps are in use, varying in candle power from 100 to 1,000 c.p., and taking 66 amperes. Distribution is carried out on poles as far as possible, and where cables are used for the series system they are of the concentric type. The streets of Christchurch are wide, none of them being less than one chain in width, and many wider, so that overhead distribution can be readily adopted. Series street lighting, low tension and 3,000 volt power mains are frequently mounted on the same poles, which are also sometimes shared by the electricity and telephone authorities. The street lamps are normally mounted on brackets on the poles used for carrying the overhead wires, but at street corners and special positions cross suspension wires are used. The original Christchurch system was direct current. The power station is now used mainly as a sub-station, and is equipped with rotary converters and mid wire boosters, and the series street lighting transformers. Direct current is supplied at 230 and 460 volts, but as far as possible A.C. motors are being installed in place of D.C. Special care is taken with the earthing of consumers' installations, every consumer being earthed to the water pipe and to neutral.

About 5,000 consumers are connected up in this way. Payment both for lighting and power is on a maximum demand basis. The wiring department supplies motors on hire or hire purchase and cooking ovens are being pushed. In addition the electricity department sells and hires electric vehicles. The country surrounding Christchurch is flat and favourable to this class of transport, while petrol is expensive and electricity relatively cheap. The vehicles are fitted with Edison batteries. A municipal garage has been opened capable of holding 60 vehicles, which can be charged at night at times of light load. Arrangements can be made for the use of the garage, including cleaning, charging and minor repairs for an annual charge based on the size of vehicle.

In reply to questions asked by Mr. Beard, who proposed a vote of thanks to Mr. Lythgoe, and by Mr. Vernier, who seconded the vote, Mr. Lythgoe stated that the low tension distribution was three-phase four wire, and that three-phase motors were employed. Star delta starters are only allowed on motors of less than 7 h.p., and all motors had to be provided with low voltage releases. The system of earthing on the low tension system had given no trouble. In spite of the absence of the regulations and restrictions underwhich we work in this country, and the fact that very little skilled labour was available to start with, there had only been one serious accident due to a man carrying a long ladder, reinforced with steel wire, with which he accidentally touched an 11,000 volt overhead line.

Reviews.

The Applications of Electrolysis in Chemical Industry. By A. F. Hale, B.Sc., F.I.C. (London: Longmans, Green & Company). Pp. ix.+148. 7s. 6d. net.

This volume forms one of the series of monographs edited by Sir Edward Thorpe.

After an introductory chapter, consisting of definitions and kindred matters, the author deals with methods of generating electric currents. These include primary batteries, thermopiles and dynamo-electric plant. The inclusion of an elementary explanation of the latter is, we feel, somewhat out of place; it is necessarily too short to satisfy the reader who desires more than an outline of this part of the subject; moreover, it can be found much better treated elsewhere, and the space which it here occupies could be put to a better purpose.

The following chapters deal with electrolytic refining and winning of metals, hydrogen and oxygen, chlorine and soda, hypochlorites, chlorates, and various inorganic and organic compounds. The treatment generally is on the usual lines and some of the chapters cover a part of the ground included in another volume recently published by the same author.

For a future edition we would suggest the desirability of giving engineering drawings of plant instead of diagrams which merely indicate principles. The average chemist is notoriously weak in his appreciation of engineering details, and the introduction of proper detailed drawings might serve towards the elimination of this weakness.

The volume will be appreciated as an up-to-date statement, though it is necessarily brief considering the ground that is covered.

The Manufacture of Aluminium. By J. T. Pattison, F.C.S. (London: E. & F. N. Spon). Pp. vii.—104. 7s. 6d.

In this small book, the author, who was at one time in charge of the chemical laboratory of the Aluminium Corporation of Wallsend-on-Tyne, gives an account of various subjects which are of interest to those engaged in the manufacture, or in applying, aluminium. These subjects include the manufacture of carbon electrodes from coke and the manufacture of pure alumina which is an essential preliminary in the electrolytic production of aluminium. Short chapters are also devoted to the founding of aluminium, the properties of a number of alloys and the applications of aluminium. Considerable space is given to the analysis and examination of works materials.

Although the title of the book is the "Manufacture of Aluminium" we have been struck by the fact that the actual process of electrolysis is only described in bare outline. This is no doubt in keeping with the reticence which is usually observed by those engaged in electrochemical work, but in this case it seems rather like "Hamlet" without the ghost.

Except for this omission a considerable amount of useful information is given, in somewhat tabloid form.

The Study of Weather. By E. H. Chapman, M.A., B.Sc. (London: Cambridge University Press). Pp. xii.+132. Price 3s. 6d. net.

To the average inhabitant of these isles there is, perhaps, no more interesting subject than the weather. Mr. Chapman has, therefore, done well to present us with an interesting little book on the study of weather which may be generally studied, though primarily intended for use in schools. He deals with the subject in chapters on Wind, Clouds and Rain, leading up from the simple observations suitable for the beginner to more difficult chapters on instruments for recording pressure of the atmosphere and to weather maps and charts. The book is full of exercises on taking observations, which should be invaluable as a mental exercise. These exercises are arranged in groups to be used at the discretion of the teacher. The book is illustrated with numerous maps and diagrams. The chapter on Clouds is particularly interesting and is illustrated with splendid photographs. The author lays special stress on the necessity for constant outdoor work and the regular keeping of a diary. It is interesting to note that this valuable addition to the Cambridge Nature Study Series was written while the author was with the B.E.F. and in the Third Southern General Hospital in England.

Correspondence.

"THE THERMIONIC VALVE AND ITS DEVELOPMENTS IN RADIO-TELEGRAPHY AND TELEPHONY."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have just read the last volume of Prof. Fleming's book on the Thermionic Valve, and I am extremely surprised that he does not mention any French name among those of engineers who have studied the question of three electrode valves.

After Mr. Langmuir had published the causes of plate current and grid current in the "General Electric Review" of May, 1915, I published myself, before anybody else (*see* The Electrician of Dec. 6, 1918, p. 674) and my British patent (No. 127,318 of April 15, 1916, published this year) the very simple mathematical theory of the operation of the three-electrode valve based on the knowledge of the slopes of these curves. This theory of mine is now claimed and has been reproduced, and possibly developed, by different authors—*e.g.*, Hazeltine, Van de Bijl, Ballantine, Carson, &c.; but having myself an obvious priority founded on a *British* publication, I feel naturally very much surprised that Prof. Fleming does not mention my name at all when writing on the mathematical theory of the three-electrode valve.

Referring to resistance amplifiers I beg to call attention to the fact that these amplifiers were first used and patented by French engineers (*see* the French patent of Péri, dated Feb. 1. 1916, and French patent of Beauvais and Brillouin, dated March 20, 1916).

I was also the first to consider high frequency amplifiers with iron wire transformers (*see* my British patent No. 127,318, of April 15, 1916) and supplied a large number of these instruments to the British forces during the war. I cannot admit that the use of iron powder (as employed in loading coils) instead of sheet iron changes anything in the principle itself. Furthermore, the tuning at every stage with iron wire transformers by a single control as in the amplifier No. 55 of the Marconi Company (*see* Fig. 131 in Prof. Fleming's book) is described in my British patent No. 130,056. I published in The Electrician of May 16, 1919, the very interesting results obtained with my tuned high frequency amplifiers.

It may be that Prof. Fleming, the inventor of the valve, has also designed three electrode valves as shown in Fig. 67, of his book (page 128), but as a matter of fact that type of valve is known as the "French Valve," and is covered by the British patent No. 126,658 of Bignet-Péri. I am, &c.,

Paris, Dec. 25. Marius Latour.

We have submitted M. Latour's letter to Prof. Fleming and the following is his reply.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: M. Marius Latour expresses his extreme surprise to you that I have not made reference in my book on "The Thermionic Valve" to certain French patents or to a Paper by him in The Electrician of December 8, 1916. Considering that the said patent specifications or their British equivalents were not open to public inspection at the date when most of my book was in print it would have been still more surprising if I *had* mentioned them. As regards his Paper on which he lays so much stress, owing to pre-occupations, I did not happen to notice it at the time it was published or if I did, I failed to make a note of it as I had then no thought of writing a book on the subject.

Having now, however, looked at this Paper I must confess I do not think his treatment of the subject in it is so epoch-making or novel that all other writers on the theory of the three-electrode valve should consider themselves as anticipated by, or under debt to it. The discussion of the problem in my book taken from the Papers of Vallauri, Hazeltine, Van der Bijl, and Ballantine with simplifications of my own, is, in my view, more elucidatory than that of M. Latour. If, however, the opportunity occurs of mentioning his contribution to the subject in a second edition of my book I shall be pleased to do it, although I cannot share his opinion as to its fundamental importance. As regards the coupling of valves in cascade by resistance coupling or iron-cored transformers, or his assumed anticipations of any of the types of valve receiver designed and made by the Marconi Company, I must decline to be drawn into the discussion of any questions of priority. The proper place for the settlement of these questions is a Court of Law, and not the columns of a scientific journal. I have had quite enough of these controversies in the past with respect to my own share in the evolution of the thermionic valve in which the final conclusion has only been reached after judgments given by such Courts.

With respect to his remarks on the "French Valve," I knew perfectly well in 1917 that a certain type of valve much used in the war was so called, but I intentionally abstained from making reference to it by that name or to the origin and use of the valve figured on my page 128 for the following reasons: My book was written and almost entirely in print before the armistice was declared, and no one knew at that time when the war would be ended. It was necessary, therefore, for me to exercise a certain discretion in reference to apparatus in actual use in the field of war. Moreover, I did not consider this type of valve involved any great novelty. In 1915, I had a "hard" or high vacuum valve made to my design, having a cylindrical anode and a spiral wire grid concentric with the cylinder.

In my laboratory note books I find records of experiments made with this valve on January 14, 1916. Now the British patent application of Bignet-Péri was not made until October 23, 1916 (No. 15,072 16), and the complete specification was not accepted until May 22, 1919. The specification was not open for inspection until still later. Hence information as to it was not until then public property. As I had in my possession a valve of similar construction, viz., cylinder and spiral grid, made for me 10 or 11 months previously to the British patent application of Bignet-Péri, I could not see any good reason for particularly nationalising this type as "the French valve," although it had many good points, such as the small bulb and convenient 4-pin attachment.

In any case, the claims of the patent, even from the Convention date, would be limited to the precise form of valve figured. After all, the main question at issue is whether the author of a book shall retain the right of private judgment in the selection of his material or whether he shall be moved by the possibility of "extreme surprise" on the part of some one if he omits to include all that other writers consider important, or to have claims to priority.

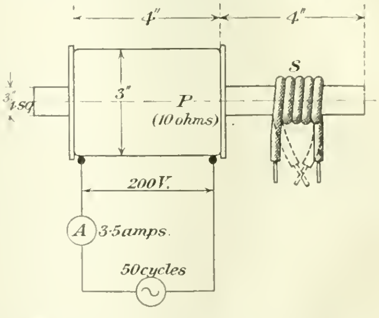
In this case my book was chiefly written during the greatest struggle in history, under a strict censorship, with patent publication mostly restricted, information closely guarded, and much knowledge carefully withheld. My object was not to give publicity to everything written by everyone on the subject, but to give as lucid a description as possible of the developments and operation of the thermionic valve. I am, &c.,

London, Jan. 5. J. A. Fleming.

A REMARKABLE PROPERTY OF A WELL-KNOWN ALTERNATING-CURRENT CIRCUIT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In connection with Mr. E. B. Brown's interesting article on p. 748 of your issue for December 26th last some observations made by the present writer of the same effect, but in a different form, may be of interest. When experimenting on a form of synchronism indicator in 1902, a magnet was used consisting of a small straight laminated core, on one end of which a magnetising coil was slipped. When a short-circuited coil, consisting of six or eight turns of 0·08 in. diameter copper wire was slipped along the core it was noticed that the current supplied to the magnetising coil at 200 volts 50 cycles, *decreased* in value by a few per cent. No explanation was forthcoming at the time, but some years later an article appeared in The Electrician dealing with the same circuit as shown by Mr. Brown, and giving the explanation. Unfortunately, the writer has no note of this reference nor author's name, although a very distinct recollection of the article as it appeared to account for the behaviour of the coil and core mentioned above.



A recent repetition of the experiment on a core and coil taken at random gives a similar result. Here, then, is a transformer whose primary current decreases when its secondary coil is short circuited.

I enclose a sketch showing the dimensions of the arrangement.—I am, &c.,

Rugby, Jan. 1. R. C. Clinker.

[We have had a careful search made through our files for the article referred to by Mr. Clinker, but at the moment are unable to put our hands on it. Perhaps our readers can help us.—Ed. *E.*]

The Electrician.

FRIDAY, JANUARY 9th, 1920.

Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.

Editorial and Publishing Offices:

8, BOUVERIE STREET, LONDON, E.C.4.

Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

New Hydro-Electric Developments.

ONE of the first questions with which the new Electricity Commissioners will have to deal is how the water-powers of this country can best be utilised for the generation of electricity, and upon whom the right to use any particular source of power is to be conferred. This question has, of course, to some extent been considered by a committee which was appointed by the Board of Trade, an account of whose deliberations were published in the ELECTRICIAN at the time (March 28, 1919). This Committee, however, mainly confined themselves to showing where power was to be found, and did not deal with the more particular, but still important, questions of the right of user, scenic amenities and so forth.

WHY HYDRO-ELECTRIC DEVELOPMENT IS BACKWARD.

The utilisation of the water powers available in this country to any great extent has been retarded in the past by two factors—the presence of a cheap supply of coal and the lack of waterfalls that can be both easily and cheaply developed. It will be seen that these two factors are of a financial rather than an engineering character. The result has been that, with one or two notable exceptions—for instance the North Wales Power and Traction Company's system and the utilisation of the tidal power of the Dee at Chester in the realm of public electricity supply, and certain cases where waterfalls have been harnessed to supply power for electro-chemical purposes on the spot, notably the works of the British Aluminium Company at Kinlochleven and Foyers, in Scotland—little has been done in this country to develop what water-power there is, and the use of our hydro-electric resources has been mainly confined to country house lighting and similar small projects.

THE DUNDEE SCHEME.

At the present time there are, however, at least two hydro-electric schemes of great interest, not only from the engineering point of view, but from the fact that the preliminary proposals in connection with them have caused a discussion and outcry comparable with that which encircles an international boxing contest. This proceeds not only from the æsthetically minded, who fear damage to an existing beauty spot, but from those who have an interest in the attraction of tourists to the region or have prior rights in the utilisation of the water supply which it is proposed to develop. The larger of these schemes is that reported upon by Messrs. MEIK & BINNIE and Mr. H. RICHARDSON, city electrical engineer of Dundee. In this the question of supplying Dundee with electricity from a chain of lakes, of which Lochs Ericht, Laidon, Rannoch and Tummel are the most important, is discussed. The flow of the River Ericht, amounting to about 15,500 cubic ft. per minute, would be utilised, and this could deal with an average load of about 5,670 kw., or a maximum load of 16,200 kw. A second power house could be erected capable of dealing with a maximum load of 23,000 kw. and an average load of 8,050 kw., while a third station of the same size could also be erected if a dam were erected near the outlet to Loch Tummel, and a large area of land flooded in consequence. The estimated cost of the complete scheme—*i.e.*, including transmission lines, &c.—would be £4,460,000, with a maximum load of 62,200 kw. and an average load of 21,770 kw.

THE CLAIMS OF ABERDEEN.

It may be pointed out that these three sources of power have already been considered by the Water Power Resources Committee, and it is rumoured that the municipal authorities of Aberdeen also have their eye on this particular conservation, so that it will be seen there is every chance of an unedifying squabble. Dundee, like other towns, is in the unenviable position of having a larger load than it can safely tackle with its present generating plant, and is also faced with the practical impossibility of extending its existing station. It is, further, probable that in a manufacturing town of its character the demands for power will greatly increase in the near future—we certainly hope they will do so—and it is, therefore, necessary that the best methods for dealing with this increase should immediately be taken in hand. This is obvious. It therefore only remains to be decided exactly what the steps taken should be, and whether it is better to embark on the very large capital expenditure which the suggested hydro-electric scheme would involve, or to be content with making what is practically an extension to the present steam station. The latter solution could, however, be only in the nature of putting off the evil day, while, as Mr. RICHARDSON points out, it is possible to obtain from the Loch Rannoch development nearly three times the number of units which the present stations in Dundee can generate, and thus the erection of only one hydro-electric station would meet Dundee's demands for some years to come, while two other stations could be erected close by when occasion required.

THE DARTMOOR SCHEME.

Few æsthetic objections to the Dundee scheme have been raised, though it has been pointed out that the suggested hydro-electric development will prejudice the rights of a large number of present users, and would probably at the same time submerge at least one village, and for these reasons necessitate considerable outlay for compensation. But in the Dartmoor scheme, though financial objections have been raised, the main opposition seems to rest on an æsthetic basis. As our readers know, it is proposed by a syndicate, known as the Dartmoor Electricity Supply Company, to develop the water-power that exists on Dartmoor, not only for the supply of electricity to the towns around, but for use in various electrochemical works which are to be erected on or near the Moor itself. At first sight it would seem that the water-power available on Dartmoor was hardly sufficiently concentrated to make such a scheme worth while; but the promoters are both business men and engineers, and have doubtless satisfied themselves that there is a *prima facie* case for such development. Considerable opposition, led by a distinguished author, has, however, been raised on the least material ground that such a development will spoil the scenery, prejudice the existing turbary rights, interfere with the powers of the water users, and generally make a dark blot on that particular part of our fair country. The opposition to it has become so vocal on account of the damage which it is said would be done to peat, china clay, tin, grazing, antiquarian, tourist and other interests that the Bill to inaugurate this development, which is to be introduced in the next session of Parliament, is likely to have a rough passage; and as the Duchy of Cornwall—who, of course, own the Moor—are moving in the matter, and the Prince of Wales is to be asked to exercise his right to impose a veto on the scheme when it comes before the House of Commons, it is hardly likely to reach the statute book in the present crowded state of Parliamentary business, which may or may not be a pity.

The Need for Judicial Consideration.

The important point, however, which we want to make in connection with both these schemes is that they are of national rather than local importance, that both the schemes themselves and the opposition to them require practical consideration; and, above all, that consideration should not take place in a political atmosphere. Now, the Electricity Supply Act provides for the consideration of schemes of this kind, as they affect the country as a whole, and that is how they should be considered. In the past, electricity supply has been too much on parochial lines. This must be altered. Unfortunately, it has suited the book of a large number of interests, and these interests are still to the fore; but their activities must be stopped. We appreciate the point of view of the beauty spot enthusiast, but in this question the doctrine of the greatest good of the greatest number must operate. The stage is now being reached when the electricity requirements of one town, however large it may be, cannot be considered by itself. Regions rather than towns are now the units, and it should, therefore, be beyond the power of one municipality or of one group of interests to obtain an exclusive control over any large block of power, or to adopt a dog-in-the-manger policy to the detriment of the public good.

The Dartmoor Hydro-Electric Scheme.

Although the number of private bills in the new Session of Parliament shows a considerable increase over those of the 1919 Session, there are not many new schemes, but one of the most interesting of these is the Bill to authorise the incorporation of a company to erect generating stations and works for utilising the water power of certain rivers on Dartmoor. The project has excited considerable interest, and it is likely to meet with strong criticism. Devon County Council and Plymouth Corporation have already decided to oppose the Bill, while those interested in the preservation of the scenery of Dartmoor are also organising opposition.

It is proposed to incorporate " Sir Gerard Albert Muntz, and Messrs. William Arthur Addinsell, Alfred Ernest Parke, John Archibald Purves, Henry John Wilson (who are to be the first directors), and all other persons who have already subscribed to or shall hereafter become proprietors in the undertaking, into a company to be named The Dartmoor & District Hydro-Electric Supply Company."

The company will generate, use and supply electrical energy or power and supply water, and for this purpose it will construct, erect, work, and use electric generating stations, reservoirs, supply channels, mains, &c.

The capital of the company will be £1,250,000 in 125,000 shares of £10 each. Powers are given to divide shares, to pay dividend on half-shares, to borrow up to one-third of amount raised, &c. The works proposed to be constructed are situate in Devon and include the following: A reservoir and a weir in the Parish of Gidleigh, a supply channel commencing in the Parish of Gidleigh and terminating in the Parish of Chagford; weirs, supply channels and reservoirs in the Parish of Lydford; a supply channel commencing in Lydford by a junction with the South Teign River and terminating in Chagford; a weir partly in Lydford and partly in Chagford, a supply channel in the Parishes of Chagford and Lydford, a line or lines of pipes and a supply channel wholly in Chagford, a line or lines of pipes commencing in Chagford and terminating in the Parish of Throwleigh; a reservoir in the Parishes of Lydford Belstone and South Tawton; a supply channel and a line or lines of pipes wholly in South Tawton; a reservoir in Lydford to be called " the Tavy Reservoir " and to be formed by means of an embankment across the River Tavy; weirs and supply channels wholly in the Parish of Petertavy; a reservoir in Lydford to be called " the Foxtor Mires Reservoir " and to be formed by means of an embankment across the River Swincombe; a reservoir in Lydford to be called " the Upper East Dart Reservoir " and to be formed by means of an embankment across the East Dart River; a reservoir in the Parishes of Holne and Widecombe-in-the-Moor to be called " the Dartmeet Reservoir," and to be formed by means of an embankment across the River Dart; a supply channel and a line or lines of pipes wholly in the Parish of Widecombe-in-the-Moor; a reservoir in the Parishes of Lydford Cornwood and Harford to be called " the Erme Reservoir " and to be formed by means of an embankment across the River Erme; a weir in the Parishes of Cornwood and Harford across the River Erme; a supply channel in Harford and Cornwood or one of them; a weir wholly in the Parish of Harford across the Piles Brook; a supply channel in Harford commencing by a junction with the Piles Brook and terminating at a point 717 yards south-eastward of the south-eastern corner of Addicombe Farm House; and a line or lines of pipes commencing in Harford by a junction with the last mentioned supply channel at its termination and terminating in the Parish of Ivybridge at a point in the River Erme.

The company may, subject to the provisions of the Act, enter upon, take and use compulsorily or by agreement certain specified lands in the parishes of Throwleigh, South Tawton, Petertavy, Widecombe-in-the-Moor, Harford and Ivybridge in the County of Devon, and may erect and maintain thereon a station or stations for generating, transforming, transmitting and distributing electrical energy or power and any material product matter or thing arising or used in the process of such generation or transformation with all necessary buildings, turbines, engines, dynamos, &c. The powers for the compulsory purchase of lands shall cease after the expiration of 5 years; and, subject to the provisions of the Act, if the works authorised are not completed within 7 years from the passing of the Act the powers shall cease.

The area within which the Company may supply electrical energy and power and water shall be the County of Devon. Any electric lines laid down by the Company under the powers of the Act shall be laid in such line or route and in a trench of such dimensions and in such position as may be agreed between the Company and the local authority, or as, failing agreement, shall be settled by the Board of Trade.

The Company shall not supply energy (except for power or to authorised undertakers or to any railway light railway or tramway or water company or proprietors or trustees of any canal or navigation) in any area which at the date of the passing of the Act forms part of the area of supply of any authorised distributors without the consent of those distributors, but that the Company shall supply energy to any authorised undertakers or to any person to whom the Company are entitled to supply energy.

The prices to be charged by the Company for electrical energy supplied by them shall not exceed such price or prices as may from time to time be approved by the Electricity Authority. The Company may, with the approval of the Board of Trade, place, erect and maintain electric lines for the supply of electricity within the area of supply above the surface of the ground.

J. H. Tucker & Company's Dinner.

At the dinner given by the Directors of Messrs. J. H. Tucker & Company, Ltd., at the Queen's Hotel, Birmingham, on the 19th ult., there was a good muster of directors, officials and employees of the firm, together with some representatives of the electrical industry in the district. Following the dinner and interspersed with an excellent vocal programme, many toasts were proposed.

Following the toasts of " The King " and " The Visitors," Mr. J. B. Tucker referred to the pleasure it gave the directors to have with them that night friends with whom they had been particularly associated in the production of munitions during the war, as well as representatives of the Electrical Trade whom, whilst they had had, to an extent, to desert them during the war, he could describe as their old friends. He pointed out that during the war period the firm had turned out something like 2,000,000 articles of warfare quite foreign to their ordinary manufactures, whilst in addition they had been called on to supply enormous quantities of their standard goods to various Government Departments. " Tucker " switches and " Tucker " accessories had been in every sphere of action—from aeroplanes to submarines.

Mr. Tranter supported, and in reply Lord Torphichen, late Director of Fuze Production, paid a great tribute to the firm's war work, and recalled many pleasant relations he had had with them.

Mr. Wade made a powerful speech in proposing the " Electrical Industry." He spoke of the present industrial situation, and said that if the labour difficulties were satisfactorily settled he thought that there were many years of prosperity in store for the Electrical and Agricultural industries, which, in his opinion, would become the two leading industries.

Mr. Rosher also emphasised the urgent necessity of capital and labour working amicably together. Without mutual confidence and effort the country would not easily recover, but given such conditions we should soon make up for lost time. He then referred to the excellent war effort of Messrs. J. H. Tucker & Company, particularly emphasising the consistent excellence of the articles they produced.

Mr. J. R. Baxter (Baxter & Impey) replied, and Mr. Bateman then proposed " The Firm," and in doing so referred to the high reputation the Firm had always held for the quality of their products. As production manager he could say that the maintenance of that reputation was their first concern. Their output was consistently increasing, but never at the expense of quality. Mr. G. T. Baker and Mr. S. G. Smith supported Mr. Bateman, referring to their long service with the firm, and the excellent quality of the goods which had made selling " Tucker " productions a comparatively easy and pleasant task.

Mr. T. R. Martin, in the course of his reply, expressed the view that the old form of relationship between capital and labour was dead. It was essential that a better feeling should exist between the two than had hitherto been the case, and wished their guests could have been present the previous night at one of their works functions to see for themselves how J. H. Tucker & Company were tackling the problem. The social and athletic side was catered for by sections dealing with dancing, concerts and other entertainments, football, swimming, tennis, shooting, &c. Many enjoyable evenings were spent in their canteen, and the firm hoped by taking their employees into their confidence and giving them the best possible working conditions.

Mr. C. L. Dalton (of THE ELECTRICIAN), an old member of the firm of Messrs. J. H. Tucker & Company, said he had been given the opportunity of seeing for himself, and he had been pleasantly surprised to notice how during their leisure moments the class distinction between the staff and works had been wiped away, making the whole band of Tucker workers a very happy family.

Joint Electricity Boards.

Already there is evidence that many electric supply undertakings will take advantage of the provisions of the Electricity (Supply) Act in order to form joint electricity boards. The Stalybridge, Hyde, Mossley and Dukinfield Joint Tramways and Electricity Board and Ashton-under-Lyne Corporation have appointed a sub-committee to draw up a scheme, and the Torquay Corporation, in conjunction with representatives from Paignton, Newton Abbot, Dawlish, Dartmouth, Brixham and Teignmouth, are considering a proposal to erect a new generating station to meet the growing demands for electricity supply in South Devon. At a meeting of representatives of the above districts, which was held at Torquay last week, a resolution was unanimously adopted approving in principle of the proposal, and a report is to be prepared, with an approximate estimate of the cost, and this will be submitted at an adjourned meeting of the Councils and companies concerned.

Mr. H. F. G. Woods, Borough Electrical Engineer of Torquay, who explained the scheme, said it had been suggested that the area should not be less than Devon or Cornwall, and possibly Devon and Cornwall combined. Cornwall was quite able to deal with its demand, but in Devon the conditions were quite different. The county divided itself into two areas—north and south of the moor. South of the moor there were three main power stations—Exeter, Torquay and Plymouth. The means of giving the cheapest supply over South Devon would undoubtedly be to link the three stations together. Unfortunately, however, there was comparatively a large barren area between each through which it would not pay to run mains. Exeter was supplying its own city, as were also Torquay and Plymouth, whilst in between there were smaller undertakings, which were looking after their own immediate areas, so the suggestion now put forward was that each of these three areas should develop itself on its own lines with the idea of linking-up when the time was ripe. Exeter and Plymouth had generating stations which were capable of extension, but unfortunately Torquay was forced to take immediate steps to improve its supply. The suggestion was that as a new station had to be built, they should put down plant which was capable of supplying a larger area, so as to give the whole of the towns and undertakings the benefit of the larger and more extended supply. It has also been suggested that the proposed new station should be erected in or near Newton Abbot, and from that centre an area of some miles radius should be supplied. It would take in Newton Abbot, and start eastward to Dawlish and Teignmouth, and on the other side, Torquay, Paignton and Totnes; whilst on the northern side would be Buckfastleigh, Ashburton and Bovey Tracey.

Mr. A. J. Tippard, for Edmundson's Electricity Corporation, said his company had interests at Newton Abbot and Dartmouth. The only suggestion his company had to make was that there might be some difficulty with regard to the financial aspect. A new generating station at present would probably cost anything up to £85 per kilowatt. If they took a low figure on calculation they would have a capital outlay of about £400,000, based on a 5,000 kw. plant. The interest on that capital at 7 per cent. would be over £24,000.

A meeting of electrical undertakers and County Councils within a radius of about 30 miles of Bristol, which was convened by the Lord Mayor of Bristol, was held at the Council House, Bristol, on the 2nd inst. to consider the propriety of promoting a Joint Electricity Authority. Representatives from the following undertakings were present: Bristol, Swindon, Stroud, Cirencester, Chippenham, Melksham, Trowbridge, Bradford-on-Avon, Keynsham, Chepstow, Gloucester, Frome, Weston-super-Mare, Cheltenham, Wedmore and Bath, and the County Councils of Gloucestershire, Somersetshire and Monmouthshire.

The Lord Mayor of Bristol presided, and Mr. H. Faraday Proctor explained the provisions of the Electricity Supply Act, 1919, and the scheme for a Joint Electricity Authority which had been tentatively outlined. Considerable discussion took place, and it was ultimately resolved that councils of the counties, cities and boroughs, and the other local authorities, and the directors of companies, except as regards the County Councils, authorised undertakers operating within the limits of the proposed district, be requested to pass resolutions agreeing to the formation of a Joint Electricity Authority, and in the case of local authorities to authorise their Electricity Committees to take such steps as may be necessary to carry out the arrangements, including the appointment of representatives on the Joint Electricity Authority. It was further resolved that the authorised undertakers and others affected be requested to pass resolutions agreeing to contribute towards the preliminary expenses on a pro rata basis with other authorities, based on the number of units sold within their respective supply areas.

In order to prepare a draft scheme for submission to a future meeting, the following committee was appointed: Ald. G. Pearson and Mr. H. Faraday Proctor (Bristol) the Town Clerk of Cheltenham, Mr. F. H. Corson (city electrical engineer of Gloucester), Mr. E. T. Gardom, Clerk to Gloucester County Council, Mr. F. Teague (city electrical engineer, Bath), the County Surveyor of Somerset, and the Electrical Engineer of Swindon.

New Year's Honours List.

Amongst the recipients of NEW YEAR'S HONOURS, the following names will be of interest to our readers:—

Baron.—The Right Hon. Sir ALBERT STANLEY, M.P., late President of the Board of Trade, and now Chairman and Managing Director of the undertakings controlled by the Underground Electric Railways Company of London.

Baronet.—Sir ARTHUR TREVOR DAWSON, M.Inst.C.E., M.I.M.E., R.N., Director of Vickers, Ltd.

G.C.B.—The Right Hon. Sir DAVID HARRELL, G.B.E., K.C.B., K.C.V.O., Chairman of the Interim Court of Arbitration, 1918 and 1919, in connection with industrial questions.

K.C.B.—Mr. SYDNEY JOHN CHAPMAN, C.B., C.B.E., Joint Permanent Secretary of the Board of Trade; Sir RICHARD TETLEY GLAZEBROOK, C.B., F.R.S., late Director of the National Physical Laboratory.

K.C.M.G.—Mr. FREDK. G. A. BUTLER, C.B., C.M.G., Director of the Overseas Division of the Department of Overseas Trade.

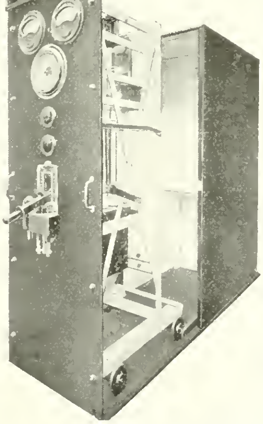
Knights.—Ald. A. BEATTIE, D.L., Chairman of the Provincial Tramways Company; Prof. A. SCHUSTER, F.R.S., late Secretary of the Royal Society; Mr. J. A. KEMNAL, managing director of Messrs. Babcock & Wilcox, Ltd.; and Mr. HUGH M. ROBINSON, C.B., I.S.O., Chief Inspector of Factories.

C.B.—Mr. WALTER GEO. GATES, Assistant Secretary, G.P.O.

C.I.E.—Mr. MATTHEW A. THOMPSON, Deputy Director General in the Punjab of the Traffic Branch of the Indian Telegraphs.

Switch Cubicles of the "Steel Truck" Type.

For the control of three-phase generators, motors and feeders up to 6,600 volts in power houses, sub-stations, &c., where floor space is limited, the General Electric Company now manufacture truck type switch cubicles. The construction adopted allows of their being placed directly against a wall, as a passageway behind is unnecessary, neither are special foundations required. The cubicles are constructed of steel so that the equipments are rendered fireproof—no marble or slate is used in their construction—all terminals, bus-bars, isolating switches, &c., being supported by means of porcelain insulators. They are designed to accommodate the usual instruments, oil-break switches, isolating plug switches, transformers and sealing boxes; the whole of this apparatus (excepting the sealing boxes), together with the inter-connections and small wiring, are mounted on a movable truck with wheels fitted with ball bearings. When the truck is withdrawn, as shown in the illustration, the whole of the gear is rendered "dead" and easy access is afforded to facilitate renewals, adjustments, cleaning operations, &c. By means of an interlock it is impossible for the truck to be withdrawn or placed in position with the oil-break switch in the "on" position. Furthermore, when the truck is withdrawn all live parts mounted on the fixed section are entirely covered in by means of a steel shutter which moves into position, thus covering the plug switch holes. Where bus-bars are required these are accommodated in a separate chamber at the top of the fixed cubicle and are entirely covered in. Inspection covers are provided to enable the bus-bars to be inspected when necessary. Any desired combination can be arranged so as to form a complete main switchboard.



VIEW OF G.E.C. TRUCK SWITCH CUBICLE, SHOWING THE GEAR WITHDRAWN.

Commercial Topics.

Census of Production.

The census of production, which will be taken in the year 1921 by order of the Board of Trade, will be limited to certain trades and businesses, including the following:—

Coal and ironstone mines, coke works at collieries, oil shale mines and shale oil works, iron mines and iron quarries, iron and steel trades (smelting, rolling and founding), tinplate trade, galvanised sheet trade, engineering trades (including electrical engineering), shipbuilding and marine engineering trades, cycle and motor trades, railway carriage and wagon trades, copper, brass, lead, tin, zinc, and other metal trades (except gold and silver refining), chemicals, coal-tar products and drug trades, building, brick and fireclay, china and earthenware, gas and electricity.

Returns will not be required from persons, companies or firms who do not employ on the average more than five persons, exclusive of officers of the company or members of the firm, during 1920.

* * * *

Trade with China.

In a report on the trade situation in the Swatow, Amoy and Foochow districts of South China, H.M. Commercial Secretary at Hong Kong reports that no great demand for machinery has yet been developed in Swatow, but there would seem to be a good opening (under normal conditions) for electric lighting plants, marine motors &c. Much pioneer work would have to be undertaken in creating a demand for these or other types of machinery, and the manufacturer must be prepared to share with the local merchant the initial expense involved. As regards electric lighting installations, it is understood that a fair number of the American "Delco" plants have already been sold, and there is no doubt that China offers a very favourable market for small installations of this type.

There is an electric supply station at Amoy, with a capacity of 500 kw., equipped with Babcock & Wilcox boilers and American generators. An ice factory contains American machinery, and there are smaller electrical and ice-making plants at Ku Lang Su. In the interior, very few of the cities and towns have yet been provided with electricity, and there should undoubtedly be good opportunities for business in this direction when conditions are more settled. Apart from electrical installations, the country supplied through Amoy would not seem to offer a very favourable market for machinery.

* * * *

Touring Exhibitions and Showrooms.

In order to help in the development of the Export Trade the Department of Overseas Trade intends to organise touring exhibitions all over the world, and to establish showrooms for British manufactures in the chief cities on the Continent. For the touring exhibitions it is proposed to collect exhibits of various articles suitable for particular markets, and these could then be carried round to the various commercial centres. In the case of the Dominions, where there is a similarity in demand, the same exhibits would be suitable to all, and it is estimated that the cost of an 18 months' tour with some 500 exhibits to the whole of the Dominions would be between £40,000 and £50,000.

In regard to the continental showrooms the idea is to secure a building in each of some 20 or 30 of the capitals and chief cities on the Continent. These could serve as permanent exhibition buildings, in which could be shown in rotation exhibits from different groups of British industries. It is laid down that both projects must be self-supporting, and on the occasion of the British Industries Fair at the Crystal Palace (from Feb. 23 to March 5) a canvass will be made of the exhibitors there, and at the branch fairs at Birmingham and Glasgow, in order to ascertain what amount of support is likely to be secured.

The idea seems to be a good one though somewhat similar work is being done by the Federation of British Industries and other commercial organisations, and if no financial assistance is to be given there is no reason why they should not continue to do it at least as well as a Government department.

* * * *

German and American Activities in Italy.

Although the war has now been over for 14 months, Italy is far from resuming her normal commercial condition, owing to lack of transport facilities, high exchange rates and difficulty in obtaining credit; and, according to Reuter, it is almost impossible to make any approximate forecast as to the prospects of Italian commerce until new commercial treaties are concluded with all countries and until the new tariff is known. In the year before the war Germany headed the list of both imports to and exports from Italy, the former amounting in value to nearly £24,000,000 and the latter to over £13,000,000. England exported over £23,000,000 and imported over £10,420,000 worth of goods; America exported almost £21,000,000 and imported £10,715,000 worth.

Germany is now trying to reconquer the supremacy which she had on the Italian market, but she finds a strong competitor in America, which has established at Rome a branch of the National City Bank, while other American banks and groups of capitalists have active agents who have already made proposals for the electrification of the railways in the north of Italy with the water-power of the Tyrol, and are organising Italo-American companies for ship-building, harbour works and the exploitation of mines. One of these companies, the Idrio, has all the plant ready, supplied with power from the great waterfalls of Terni, to produce ammonia by a new process, by which they claim that the price of ammonia will be lower than in any other country. With regard to the conquest of the Italian market, one of the greatest difficulties to be overcome is the fact that German firms are in the habit of allowing the most liberal terms as to credit.

Electricity Supply.

BRYNMAWR Urban Council has decided to apply for a provisional electric lighting order.

An electric supply scheme, prepared by Mr. J. J. Woods for CAVAN Urban Council, is estimated to cost over £8,000.

DARWEN Corporation have applied for sanction to borrow £27,308 for the laying of mains in order to obtain a supply of power from the Lancashire Electric Power Company at wholesale rates.

The Ministry of Health has approved the scheme of YORK Corporation to erect hydro-electric works at Linton Lock, but the sanctioning of the necessary loans has been deferred until revised estimates are submitted. Underground are to be substituted for overhead cables from York to Linton.

According to a report of the BARNSTAPLE borough electrical engineer (Mr. J. W. Hadfield), it will be necessary to expend £15,000 upon extensions of plant and mains in order to meet existing demands for electrical energy. Extensions of mains, estimated to cost over £1,800, are to be carried out at once.

The CHESTERFIELD electric supply accounts for the year ended March 31 show revenue £24,647 and gross profit, after meeting working and general expenses (including war service allowances), £5,943. Interest, repayment of loans and sinking fund required £7,299, and, after taking into account interest on investments, there was a net deficit of £1,272.

The Corporation is recommended to fix the remuneration of three superintendents and four shift engineers at ACCRINGTON electricity works as follows: Superintendents, £330 (compared with £277 at present with war bonus); senior shift engineer, £282 (£248); other shift engineers, £264 (£235). The remuneration is to be fixed at a basic rate, plus 20 per cent., plus £90.

In order to meet the higher costs, WOLVERHAMPTON Corporation has advanced by a further 15 per cent. the charges for the supply of electricity on all accounts (including meter rent), making a total increase of 100 per cent. over pre-war rates.

A new agreement had been made with the Midland Electric Corporation for Power Distribution for a supply of electrical energy in bulk. It was stated at the last meeting of the Corporation that when the company had their full quota from the Corporation they would consume 4,000 kw. per year, and the revenue would be nearly £30,000 per year.

At the meeting last week BELFAST Corporation agreed to release Sir John Snell from his position as consulting electrical engineer and Mr. J. H. Rider was appointed to succeed him. The Electricity Committee has increased the charges for electricity for light and power by 2¼ per cent., making the percentage increase 10 per cent. Councillor Riddell explained that the delay in connection with the new power station was due to the difficulty in getting a supply of cement. The increased charges for electricity were due to the advance in wages, the enhanced price of coal and other materials. By the large alternating-current set at the electricity station, which supplied the shipyards, the average consumption of coal per unit had been reduced by slightly over 10 per cent. The chairman of the Committee (Sir James Johnston) explained that the coal used for the generation of electricity for domestic purposes would not be more than about 1 per cent. of the total consumption at the station.

The Electric Supply Committee reported to BIRMINGHAM Corporation on Tuesday that owing to the demand for electricity during late afternoons having increased to a degree which involved risk to the plant it was necessary in the early part of November to curtail the supply to certain consumers. After the Armistice the demand fell considerably, but new business was accepted only conditionally on an undertaking being given by the new consumers either to take supply only during certain hours when the load was not at its greatest, or to cease taking supply altogether if necessary. The Committee regretted that it should have been necessary partially to enforce the restrictive conditions on which the consumers were accepted. Careful consideration has been given to the possibilities of supplementing the existing plant capacity, in view of the probability that the new permanent station at Nechells will not be in commission for a considerable time. The Committee are negotiating for a temporary supply for 12 months from the Shropshire, Worcestershire & Staffordshire Electric Power Company, and are also installing a small supplemental generating plant at Chester-street Station. The provision of a storage battery at Water street station is a larger measure which a sub-committee strongly favours as a reserve for times of emergency or exceptional demand. The erection of the battery merely anticipates what would in any case have to be done a little later, and the present load makes an earlier installation imperative to meet the demand anticipated in the winter of 1920-21. The Committee received tenders for the necessary plant and submitted particulars of the cost based upon the most favourable tenders, as follows: Tudor Accumulator Company's tender for battery £53,488, English Electric Company's tender for boosters £9,002, Bertram Thomas' tender for switchgear £1,676, Callender's Cable & Construction Company for cables, &c., £3,772, making, with £3,250 for cost of building, a total of £71,188.

The report and recommendations were adopted.

At the meeting of the HAMMERSMITH (London) Borough Council on Wednesday, the Electricity Committee reported that the premises of 76 additional consumers, representing a maximum of 2,409 8 c.p. lamps, had been connected, and that the number of consumers taking current from the Council's mains was now 4,935. Seven applications had been granted for the hire of electrical apparatus, including four radiators to the King's Theatre and three radiators to the Hammersmith Club Society. For the supply of a 3-ton geared trolley for use in connection with the raising and lowering of transformers into the sub-station of the powdered fuel plant house, an order has been placed with the Vaughan Crane Company. Several extensions of mains were authorised, mainly to supply electric power to factories and business premises.

The question of the extension of electricity supply to small properties in the borough has been under the consideration of the borough electrical engineer (Mr. G. Gilbert Bell), and it is proposed to invite electrical contractors to submit schemes and terms for wiring.

In a report by the Law and Parliamentary Committee on the Electricity Supply Act of 1919, it is stated that the sub-committee of the conference of local authorities owning electricity undertakings in Greater London is dealing with a scheme for dealing effectively with the question of electricity supply in the greater metropolitan area, inasmuch as the new Act in no way places obstacles in the way of local authorities combining by mutual agreement for the purpose of establishing a joint electricity authority.

Some reference was made by Ald. Wilkins to the projected power scheme for the East Midlands at the meeting of the Derby Chamber of Commerce last week. After referring to the changes in the Electricity (Supply) Act, he said that owing to the suggested formation of a company for the whole Erewash Valley, the local corporations, recognising the need of joint action, formed a committee and consulted an engineer who had recently submitted his report to the nine associated towns. The electrical engineers of the towns concerned had now been asked to furnish a report as to the practicability of the scheme. It had been hinted that they could not see their way to recommend the adoption of the scheme. An estimate of the initial stage, including the transmission cables and the establishment between Trent Station and Long Eaton of large power station, put the cost between £5,000,000 and £6,000,000, but when completed the cost would be between £14,000,000 and £15,000,000. The adoption of the scheme would mean that Derby ratepayers would have to purchase their eletiricity in bulk and distribute it at a price in keeping with payment to a joint board. After weeks of study he was of opinion it would have entailed increased cost to the consumer in Derby. Representatives in Parliament seemed to have imagined that a super-power station could necessarily generate electricity so cheaply and deliver it 15, 20, or 30 miles away at a lower figure than the municipalities themselves could do it in their own localities. Now the compulsory clauses had been dropped there was a possibility of another scheme drawn up by the local engineers being adopted.

Electric Traction.

Burnley Tramways Committee recommend that the salary of Mr. H. Mozley, the tramway manager, be increased to £675 from £575 per annum, and that Mr. H. Broughton, cashier, be appointed chief clerk.

Rapid progress is being made with the scheme of the Great Eastern Railway Company for converting to Electric Traction the Enfield Branch Line from Liverpool-street Station. The new electric service will be a great boon to thousands of City workers who use the line daily.

The equipment of the York to Haworth railless trolley route is making good progress and Ald. Meyer, chairman of the Tramways Committee, stated at the Council meeting on Monday that the four railless cars ordered would run about 100,000 miles, and their cost would be 4d. per mile less than petrol omnibuses, and would thus effect a saving of about £1,600. A proposal to divide the Tramways and Electricity Committee into two separate committees was defeated.

An inquiry was held at Harwich on the 1st inst. into the application of the Corporation to borrow £3,000 for the purchase of two electric vehicles for refuse collection. It was stated that under the proposed system the scavenging of the borough would be more efficiently done, and it would effect a net annual saving of £187. The price of the two vehicles would be £2,350, the conversion of a building into a garage £300, and equipping the building with motor generators and distributors would cost another £300. The new vehicles would collect eight tons of refuse per day, and electric current would be obtained from the G. E. Railway Company at 1½d. per unit.

A new system of signalling has been introduced at Victoria station by the South Eastern and Chatham Railway Companies. The most novel feature of the system, which is operated electrically, is the adaptation of the "three position" signalling. The horizontal position and the red light stand as usual for danger, but the signal moves upward to starting position showing a white light to indicate "clear to next signal." To signal "all clear" the arm moves into a vertical position, showing a green light. Three position signalling is employed only on a few lines in England, but it is probable that the new signals will be extended throughout the system if the experiment proves successful.

Considerable interest has been taken in the working of a parcels delivery van which has been run by the Bradford Corporation tramways department for the past three years. The van is worked like a trackless trolley vehicle, but it is also equipped with a storage battery capable of operating for 8 or 9 miles, when the vehicle has to traverse roads along which there are no electric wires. The Ministry of Transport have become interested in the vehicle and have asked for particulars. The Bradford vehicle makes two journeys to Leeds every day with parcels. It is claimed that the system is the cheapest kind of transport known, and that the running costs are much lower than those incurred in connection with motor-lorries. At present the powers of the Bradford Tramways Department are limited to the carriage of light parcels, but it is proposed to seek extended powers to enable the department to take any kind of goods and up to any weight.

Imperial and Foreign Notes.

Among the public works recently authorised by the Government of the Union of South Africa were the electric lighting of railway streets and quarters at Kroonstad, the erection of 64-ton electric cranes at Durban Harbour, and of five 4-ton electric cranes at Table Bay.

It has been decided to construct a dam at Grand Falls on the Nepisiquit River, in order to develop 10,000 h.p. for transmission to Bathurst, New Brunswick, where it will be used for the operation of saw and pulp mills, &c. Two generators will be installed, but provision will be made for a third unit. The transmission line voltage will be 50,000 to 55,000.

The Municipal Council of Marseilles recently decided to construct an underground electric railway in order to relieve the congestion of the streets.

It is reported that the Belgian Government has decided to carry out a big scheme for converting the Belgian Railroads to electric traction and a start will be made on the Brussels-Antwerp line.

The period for the registration of patents, trade marks, and designs in different parts of Poland under documents issued by the Patent Offices of States to which such parts of Poland were formerly subject has been extended until June 30, 1920.

The Italian Government proposes to give a concession to an American syndicate to utilise the water powers in South Tyrol, provided electric energy is supplied to the Italian State Railways at 10 per cent. above cost price.

By a recent decree firms engaged in the erection of hydro-electric plant and the development of water power and irrigation schemes in Italy will be granted substantial subsidies and certain immunity from taxation for varying periods from 10 to 15 years. The decree applies to schemes commencing from Jan. 1, 1919, and the concessions will end in 1940.

In consequence of the difficulty in getting British coal and of its increasing cost an engineer (M. L. Neu) has submitted a proposal to the French Ministry of Reconstruction for transmitting electrical energy from Dover to France. M. Neu thinks it is feasible to lay submarine electric cables from a power station at Dover across the Channel and as far as Lens, which would be a distributing centre for a circle of 45 miles radius.

We wish to draw attention to the fact that the Patents and Designs Act, of 1919, extends the term of all patents in force from 14 to 16 years, and therefore the patents given in our list last week will not expire until 1922.

Miscellaneous.

Electricity supply undertakings which are in difficulties as regards meeting demands on their mains are asked to communicate with the Electrical Development Association, when, as the lawyers say, "they will hear of something to their advantage."

First aid has always been a necessary part of all welfare work, and employers who have the interest of their employees at heart might well use Iglodine as a first aid dressing, owing to its value as a means of preventing blood poisoning. This preparation is made by Iglodine Company, Ltd., Newcastle-on-Tyne.

The Memorial Fund to the late Sir Wm. Ramsay now amounts to £51,274. Recent contributions include £3,500 from Prof. Baskerville on account of the American subscriptions, and £1,571 9s. 5d. from Prof. H. Kamerlingh Onnes on behalf of subscribers in Holland. Further contributions to the Fund are invited and should be sent to the hon. treasurers, Lord Glenconner and Prof. J. Norman Collie, at University College, London.

It is announced that the second International Engineering and Machinery Exhibition, organised by the Machine Tool Trades Association, will be held at Olympia from Sept. 4 to 25, 1920. A certain amount of space is still available, and applications are being received from non-members. The exhibition of machine tools and small tools is restricted to Members of the Association. Inquiries should be addressed to the Secretary, Machine Tools Trade Association, Queen Anne's-chambers, Tothill-street, Westminster, S.W. 1.

In a claim for substituted rates by women in the mica industry for electrical appliances, the Industrial Court gave its Award on Monday in the case between the Electrical Trades Union and the National Federation of Women Workers and the Micanite & Insulators Company and the Mica Manufacturing Company. The Unions contended that the works of the firms should be classed as "engineering shops," but the Court decided against this claim. The workers concerned are to receive advances as follows: Women 18 years of age and over, 3s. 6d., and girls under 18 years of age 1s. 9d. per full ordinary week. The decision is to take effect as from the beginning of the first pay period following Dec. 15, 1919.

Thanks to the energy of Mr. W. W. Lackie, city electrical engineer of Glasgow, a strong Advisory Committee has been formed to deal with matters affecting the Electrical Trades Benevolent Institution in Glasgow and district. The members of the Committee are Prof. Magnus MacLean (chairman), Messrs. W. Roxburgh (hon. secretary), F. Anslow, G. L. Black, A. S. Hampton, W. W. Lackie, Alex. Lindsay, R. B. Mitchell, Archibald Page, J. S. Nicholson, J. E. Sayers, P. J. Sims, E. J. Skinner and Joseph Taylor.

Advisory Committees are now working at Cardiff and Glasgow, and will assist the Institution by reporting on local cases which require assistance, and also in obtaining contributions, organising concerts, &c.

Tenders Invited and Accepted.

Irvine Corporation require tenders by Jan. 19 for electric light wiring in 54 dwelling houses. Specifications from the Town Clerk.

Coventry Tramways Committee require tenders (by Jan. 20) for supply of 1,000 tons of steel tram rails. Specifications from the General Manager.

Denny and Dunipace Corporation require tenders by Jan. 16 for electric light wiring, in connection with the housing scheme. Schedules from Mr. Jas. Strang, architect, Falkirk.

Tenders are required by Jan. 12 for electric light wiring in connection with Glasgow Corporation's Coplawhill area housing scheme. Schedules, &c., from the City Electrical Engineer.

Manchester Electricity Committee require tenders by Jan. 14 for a 2-ton electric lorry and a 10-15 cwt. electric van. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Bradford Corporation want tenders by Jan. 28 for supply of two electric battery locomotives. Particulars from Mr. J. Garfield, Esholt Hall, Shipley.

Bournemouth Tramways Committee require tenders by noon Jan. 20 for reconstruction of about 12 miles (single track) of permanent way. Specifications, &c., from the Manager.

Aberdeen Electrical Committee require tenders for two water-tube boilers, superheaters, economisers, &c. Specifications from the City Electrical Engineer, Mr. J. Alex. Bell, and tenders by noon Jan. 31.

Tynemouth Corporation invite tenders for ten 250-k.v.a. transformers. Specifications from Mr. C. Turnbull, borough electrical engineer, Electricity Works, and tenders to the Town Clerk, by Jan. 12.

Battersea (London) Council require tenders by noon Jan. 21 for 5,000 kw. turbo-alternator, &c., 1,500 kw. rotary converter, switchgear, &c. Specifications from the Borough Electrical Engineer, Lombard-road, S.W.11.

Pontypridd Urban Council invite tenders for the supply and erection of a rotary converter, transformer and switchgear. Specifications from the engineer, Mr. J. E. Teasdel, and tenders to the clerk, Mr. H. Leonard Porcher, Municipal-buildings, Pontypridd, by noon Jan. 30.

Islington (London) Council require tenders by noon Jan. 28 for one year's supply of stores for their electricity department, including cables, meters, lamps, transformers, carbons, &c. Specifications can be obtained at the Town Hall.

Stepney (London) Electricity Supply Committee invite tenders for manufacture and erection of two water-tube boilers, economisers and other accessories, and one 5,000-kw. turbo-alternater condenser, accessories and switchgear. Specifications from Mr. Wm. C. P. Tapper, M.I.E.E., borough electrical engineer and manager, and tenders to the Chairman of the Committee, 27, Osborn-street, Whitechapel, E., by noon, Jan. 22.

Ilford Urban Council invite tenders for the supply of 1,000 kw. of converting plant, cooling tower, motor-driven air compressor and l.t. cables. Specifications from the engineer, Mr. A. H. Shaw, Electricity Works; and tenders to the clerk (Mr. Adam Partington), Town Hall, Ilford, by Jan. 27.

Barnes Urban District Council invite tender for the supply of water-tube boilers, economisers, draught plant, turbo-alternators, condensers, air and circulating pumps, transformers and rotary converters. Specifications from Mr. C. S. Davidson, M.I.M.E., M.I.E.E., Electricity Works, High-street, Mortlake, S.W.14. Tenders by noon of Jan. 12.

Dundee Corporation invite tenders for supply and erection of three 750 kw. and one 300 kw sets of rotary converting machinery, and one 12-panel, 11,000 volts e.h.t. switchboard, and three D.C. machine control panels. Specifications from the General Manager and Engineer. Tenders must be lodged with the Town Clerk by Jan. 23.

The Electricity Committee of Hull Corporation invite tenders for the supply and erection of a 10,000-kw. turbo-alternator with exciter and one condenser outfit. Forms of tender from the City Treasurer, Mr. T. G. Milner, and tenders, addressed to the Chairman of the Electricity Committee, Guildhall, Hull, must be in by Jan. 23.

Hammersmith (London) Borough Council invite tenders for material required for boiler setting and furnace work, or supplying materials and executing the work, or for executing the work only. Specifications from the borough electrical engineer, Mr. G. G. Bell, 88, Fulham Palace-road, W.6, and tenders to the town clerk, Mr. Leslie Gordon, Town Hall, Hammersmith, W.6, by Jan. 20.

Hammersmith (London) Council also desire to be furnished with particulars of wiring systems which contractors are prepared to submit suitable for property to be erected in connection with the Council's housing scheme. Particulars from the Borough Electrical Engineer and propositions to the Town Clerk by Jan. 20.

Middlesbrough Gas and Electricity Committee has ordered two sets of 350 kw. gas engines and generators from Messrs. Browett, Lindley & Company at £7,946.

The London County Council has accepted the tender of Clough, Smith & Company at £8,650 2s. 1d.) for overhead electrical equipment for the Lee Green to Eltham tramways. There were two other tenders at £9,838 15s. 6d. and £11,323 9s. 8d. respectively. The contract for the supply of l.-t. electric cables has been given to the Western Electric Company at £23,803 9s. 1d. There were seven other tenders, varying from £24,227 10s. to £25,593 14s. 1d.

Institution Notes.

Mr. W. Ingham, M.Inst.C.E., chief engineer of the Rand Water Board, has been elected President of the South African Society of Civil Engineers for the 1920 session.

Royal Institution: The Friday evening discourse on Jan. 16 at 9 p.m. will be delivered by Sir James Dewar on "Low Temperature Studies," and on Jan. 23 by the Hon. Sir Charles Parsons on "Researches at High Pressures and Temperatures."

The Association of Engineering and Shipbuilding Draughtsmen and its various branches seem to be displaying considerable activity, and a good programme of lectures has been arranged for the 1919-20 session. Apart from the branch lectures, the Association is responsible for the publication of 12 lectures, and among these are the following: "The Lubrication of Bearings," J. Davison (member, Newcastle); "Water Tube Boilers," W. J. Evans (member, Newcastle); "The Submarine," H. W. Townsend (member, Teeside); "Commutators as Structures," R. J. Roberts, A.M.I.E.E. (member, Manchester); "Steam Raising from Waste Materials," Douglas Wilson, A.M.I.M.E. (member, Manchester); "Design of a 40-ton Titan Crane," P. A. Arbeny and H. W. Mellor (members, Bath); and "Gearing Design," M. Coronel (member, Manchester).

Business Items, &c.

Jesse Roper and Thos. Grundy, electricians, &c., 82, Park-street, Peel Green, Patricroft, have dissolved partnership. Debts by Mr. Roper.

From Messrs. George Ellison, of Perry Barr, Birmingham, we have received a most artistic calendar, with monthly tear-off sheets.

The new telephone number of Messrs. Francis Polden & Company, Ltd., electrical engineers, is City 5538-9.

The Key Engineering Company, Ltd., have sent us a neat celluloid vest pocket calendar for 1920.

We have to acknowledge from the Keighley Gas & Oil Engine Company, Ltd., the receipt of a useful date remembrancer with daily tear-off slips.

We understand that the slide rule for complex quantities which was described by Mr. W. H. Grinsted on page 197 of our issue of Feb. 14, 1919, has been placed on the market by Messrs. J. Davis & Son (Derby), Ltd., and may be obtained at a price of two guineas.

The partnership between Chas. R. Bussey, Fredk. A. P. Payne and Alex. Bussey (trading as Payne, Bussey & Sabberton Bros.), motor, electrical and general engineers, Palace-street and St. Martin-at-Palace Plain, Norwich, has been dissolved. Debts by C. R. & A. Bussey.

The well-known firms of Pinchin, Johnson & Company, Ltd., and Wilkinson, Haywood & Clark, Ltd., have been combined, and in future the joint head offices will be General-buildings, Aldwych, London, W.C. Telegrams: *Pinchin Phone London* and *Storson Phone London* Telephone: City 7840. There will be no change in the policy of either house.

We are informed that the British Electrical Federation and most of its member companies have returned from the Manchester Hotel, Aldersgate-street, to Electrical Federation Offices, 88, Kingsway, W.C.1. As the Government has retained part of the building, the engineering and stores departments of the Federation are for the present located in adjacent premises at 11/13, Southampton-row, while the Electrical & Industrial Investment Company and other finance companies are at 4, Broad Street-place, E.C.

Catalogues, Price Lists, &c.

Credenda Conduits Company, Ltd., Chester-street, Aston, Birmingham, has issued a new list, with prices and illustrated particulars of the "Creda" electric iron and kettles, porringers, connectors, &c.

From the Commercial Electrical Accessories, Ltd., 9, Diana-place, Euston-road, N.W.1, we have received a useful diary, blotter and calendar for 1920. The company will send one to any reader who requires one.

Automatic and Electric Furnaces, Ltd., have issued a leaflet giving particulars of the Wild-Barfield electric furnaces with salt bath type metal pots, and also Bulletin No. 17, which is devoted to the location of hardening shop faults.

A pamphlet recently issued by the Telegraph Condenser Company, Ltd., of Vauxhall-street, S.E., gives particulars of the "Radamax" spark indicator and plug tester which indicates clearly whether or not the plug is sparking in the cylinder.

We have received from the General Electric Company a copy of their Bulletin No. 11, which deals with textile mill electrification. The publication of this Bulletin comes at a most opportune moment, and we recommend all those interested to make themselves acquainted with its contents. It is needless to say that it contains a large amount of very interesting information and that the illustrations and general get-up are quite up to the standard studied by the Company in publications of this kind.

In a pamphlet issued by the Chloride Electrical Storage Company, Ltd., Clifton Junction, Manchester, illustrated particulars and prices are given of "Exide" and "Clifton" portable accumulators for lighting, ignition and all portable uses. Large stocks of standard cells are kept ready charged at the company's works, and the accumulators, which are British made throughout, can be supplied packed for shipment. The information given includes details of sizes, weights and capacities of the various types of cells.

Personal and Appointments.

Sir Oliver and Lady Lodge left Southampton on Monday on the ss. "Lapland" for New York.

Acting Captain J. A. Slee, C.B.E., R.N., has been appointed Technical Superintendent and Adviser on the staff of the Marconi International Marine Communication Company.

We understand that Mr. Hadyn T. Harrison has now returned to civil life from his naval duties, and is carrying on consulting work at 11, Victoria-street, S.W., and at his research laboratory, White Horse-lane, Canterbury.

Mr. Joseph Wilkinson, M.I.E.E., M.I.Mech.E., has resigned his position as engineer of Hull Corporation Tramways, and has started in practice as an electrical and mechanical engineer at 4, Morpeth-street, Hull. Telegrams: Cables, Hull; telephone: Central 5,247.

We regret to learn that Mr. C. W. Mallins, tramways manager at Liverpool, is retiring through ill-health, and the Corporation is asked to agree to the retirement of Mr. Mallins, with a pension of £660 per annum. Mr. Mallins has been with the Corporation for 22 years, 14 of which he has been manager, and he was previously 23 years with the old tramways company. Under his management the revenue has grown from £550,000 to £11,176,969 per annum.

There was an interesting gathering of the staff of Messrs. Babcock & Wilcox, Ltd., on New Year's Day, when the managing director, Sir James Kemnal, acknowledged the congratulations received from the members of the large staff on the knighthood just conferred upon him. In reply, Sir James warmly thanked them, and said he wished to take the opportunity of its being the first day of a new year of business—a year in which the shadows of war were past—to say something with regard to their business. He was glad to say that their order books were reasonably well filled, but many of them knew the anxiety resulting from the difficulties under which they laboured. In the past the company had had a reputation for speedy correspondence, for speedy execution of drawings, and for rapid manufacture, due to their works organisation, and also for general reliability. In all those the staff had played an important part. He was anxious that that reputation and the good name of Babcock & Wilcox, Ltd., in which many of them were financially interested, and the rest platonically, should be retained. Among the difficulties they had to contend with at present there were those relating to and following in the wake of the moulders' strike, which had interfered with the activities of other engineering sections. There have been other strikes and there had been much holding back. At the moment the idea seemed to prevail that giving more money to everybody would ensure an improvement, but that was wrong reasoning. It was not money that was wanted, but production of goods. The whole world needed goods and more activity on the part of employer and employed.

One of the worst features in his own experience that British industry had ever had to contend with was the reduction to 48 hours per week in the works, and still less in the offices. The idea that a man could produce as much in 48 hours as in 54 was a fallacy from the start—if in the 54 hours he was doing his duty. There was a good deal of fallacious talk at present about the interests of the capitalist in the results of the combined labours of the community. The actual part played by the so-called capitalist was to enable the men to carry on, and in reality the proportion of profits taken by him was small in comparison to that taken by the workers, who received by far the greater share.

Appointments Vacant.

An assistant lecturer and demonstrator in electrical engineering is required at the University of Sheffield. Salary £300. Applications to the Dean of the Faculty of Engineering by Jan. 24.

Gallygaer Urban Council require an electrician experienced in overhead and underground distribution cables, &c. Applications to the Electrical Engineer, Mr. H. McNaul, Bank-chambers, Bargoed.

Cardiff Corporation invite applications for the position of city electrical engineer, salary £1,000, rising to £1,250 per annum; and also for the position of tramways general manager £800, rising by annual increments of £50 to £1,000 per annum). Applications, on forms to be obtained from the Town Clerk (Mr. Cecil G. Brown), must be in by Jan. 15.

A chief lecturer in electrical engineer (£350, rising to £400 per annum), an assistant lecturer in civil and mechanical engineering (£300) and an assistant lecturer in physics (£300) are required at West Ham Municipal Technical Institute. Applications to the Principal by Jan. 12.

Shanghai Municipal Council require assistant mains engineers (salary 350 taels per month) and assistant installation inspectors (230 taels) for their electricity department. Applications to Messrs. Preece, Cardew, Snell and Rider, 8, Queen Anne's Gate, S.W.1, by Jan. 22.

The Civil Service Commissioners announce that an examination will begin on May 4 next for filling 10 vacancies for assistant examiners in the Patent Office. Copies of the regulations may be obtained from the Secretary, Burlington-gardens, London, W.1.

Obituary.

Although he was not an electrical engineer, Mr. Alexander Wood, always known to his friends as "Alec," was one of those genial personalities who are so rarely met with in these bustling days. We much regret to record his sudden death at his home at Brighouse in Yorkshire, on Sunday, the 21st ult. Mr. Wood will be greatly missed for his constant cheerfulness, wonderful sympathy, sincere friendship and readiness to help others. The members of the Engineers' Club, Manchester, of which he was a member and a regular habitue, will find it difficult to realise that he has gone.

Companies' Reports, &c.

The Mackay Companies have declared a dividend of 1½ per cent. on the Common Stock for the quarter ended December.

The Canadian General Electric Company, Ltd., recently made an issue of 10,000 common shares at $100 each in order to provide money for extensions.

The accounts of the North Wales Power & Traction Company, Ltd., for the year ended June 30, 1919, show a credit balance of £167, which is to be carried forward.

It is announced that the entire holding of Messrs. Speyer Brothers in the Underground Electric Railways Company of London has been acquired by Messrs. Barnato Brothers on behalf of whom Mr. S. J. Joel

It was stated at the recent meeting of the Colombian Mining and Exploration Company, Ltd., that a representative of the General Electric Company of New York had visited the company's property and had inspected the power plant. There was some fear that the company would suffer disappointment over dates of delivery of the new plant, but temporary arrangements had been made to utilise the existing power for working the first unit of 10,000 tons per month.

The report of the International Light and Power Company for year to 30th June, 1919, states that after providing for the debenture interest and sinking fund, administration expenses in London and Canada and interest on loan, the net profit is £28,939, which with £34,099 brought forward (less accrued preference dividends paid of £33,904) gives £29,134. After deducting preference dividends for the year of £12,757, and placing £2,500 to reserve, £13,877 was carried forward.

In the course of the proceedings at the recent meeting of the Consolidated Signal Company, Ltd., the managing director (Mr. H. G. Brown) stated that the results of the trading for the year ended June 30, 1919, were practically as good as those of the previous year. The subsidiary companies had distributed £20,088 4s. in dividends, leaving £17,231 12s. 10d. as unappropriated profits. Their own profit and loss account, including the dividends received from the subsidiary companies, showed a balance of £20,380 19s. 8d., and the available total was £29,661 13s. 11d. The interim and final dividends on the preference shares, and the dividend of 2s. per share (or 10 per cent.) on the ordinary shares, absorbed £19,534 10s. 10d., leaving £10,127 3s. 1d. to be carried forward. Their signalling business was still far below pre-war volume, and no marked increase in orders could be expected until the future relations between the Ministry of Transport, the Railway Administration and labour were determined with reasonable finality. There was a vast accumulation of work required to bring signalling on the railways up to the pre-war standard. They had every reason to expect that they would be fully occupied as soon as those grave political and financial questions were settled. Increased production was the real solution of the present situation. When the unions became willing to withdraw the limits on production, then they could face the present higher rates of wages with perfect equanimity. High wages and limited production, resulting in increased costs, had been a serious handicap as regards foreign orders. Nationalisation was not the solution of the present problems, although it appeared to be so theoretically. Nationalisation, to be successful, required a perfection of character in all men. The majority of their works were closed on account of the moulders' strike

For the year ended Aug. 31, 1919, the gross revenue of the Adelaide Electric Supply Company, Ltd., was £185,908, compared with £174,254 for the previous year. After payment of management and general expenses in Adelaide and London, and providing for interest and sinking fund on the 5 per cent. debenture stock and for interest on the 6 per cent. consolidated debenture stock, the directors have written £959 off cost of issue of A preference shares, placed £3,000 to reserve for income tax and £5,000 to general reserve (raising the latter to £85,000), leaving £58,398. Deducting the preference dividend for the half-year ended Feb. 28, 1919, and the interim ordinary dividend, there remained £33,419, which has been applied in paying the preference dividend for the half-year ended Aug. 31, 1919, and a final dividend of 7 per cent., free of British income tax, on the ordinary shares, making 12 per cent. for the year and leaving a balance of £1,419. This sum, with £16,942 from the previous year, made a total of £18,360 5s. 1d. to be carried forward. During the first nine months of the year under review a satisfactory increase was shown in all departments. The prospect of a record year was, however, upset by the prolonged strike of seamen in Australia, and the net profit was seriously diminished, as the authorities imposed drastic restrictions in the use of electricity, and for a time the supply of current for industrial power was prohibited. The company's sale of electricity was reduced by approximately 50 per cent. during the strike. The company's business is rapidly outgrowing the capacity of the existing power house at Adelaide, and the directors have decided to equip a new power house at Osborne, Port Adelaide. To provide funds for this purpose, an issue of 250,000 5 per cent. (free of tax) A cumulative preference shares of £1 each was made in July. At the end of the year there were 25,049 consumers (against 21,917 in 1918), and the total connections were 30,247 kw. (27,207 kw.), including 12,618 h.p. (11,351 h.p.) in motors. The area of the districts covered by the company's statutory powers is approximately 155 sq. miles, with an estimated population of 224,000; and a supply of electric light and power is now available in 500 miles of streets, an increase of 22 miles. The total consumers show an increase of 14 per cent., and the power supply increased by 11 per cent., while the total connections (including lamps, motors, heating cooking and other apparatus) increased by 11 per cent.

New Companies.

APPAREIL MAGNETIQUE C'MPANY, LTD. (161,79).—Private company. Reg. Dec. 18, capital £4,000 in £1 shares, to take over the business of a company of similar name, and to carry on the business of medical electricians, manufacturers of electrical, surgical and calisthenic appliances, &c. Managing director: G. Petterson. Reg. office: 2, Charterhouse-street, E.C.

B.S A. TOOLS, LTD. (161,652).—Private company. Reg. Dec. 15, capital £500,000 in £1 shares, to acquire the goodwill of that branch of the business of the Birmingham Small Arms Company which relates to the manufacture of and dealing in automatic machine and small tools for use in engineering and other trades, &c. First directors are: Sir Hallewell Rogers, P. Martin, E. M. Griffiths and W. L. Bayley.

BUGLASS & JAMIESON, LTD. (10,783).—Private company. Reg. in Edinburgh Nov. 29, capital £6,000 in £1 shares, to carry on the business of electrical and mechanical engineers, millwrights, motor engineers, &c. First directors are J. F. Buglass and W. E. Jamieson. Reg. office: 65, Trades-lane, Dundee.

COMMERCIAL IGNITION COMPANY, LTD. (162,156).—Private company. Reg. Dec. 30, capital £3,000 in £1 shares, to take over the business carried on by W. Hill and C. J. W. Piggott as the "Commercial Ignition Company," and to carry on the business of mechanical and electrical engineers, &c. First directors are W. Hill, C. J. K. Piggott and L. P. Fulkes. Secretary: H. Hill. Reg. office: 95, Lavender-hill, S.W. 11.

. H. DAVIES & COMPANY, LTD., (161,802).—Private company. Reg. Dec. 18, capital £12,000 in £1 shares (2,000 6 per cent cumulative preference), to take over the business of an electrical accessories manufacturer carried on by C. H. Davies at 153, Bracebridge-street, Birmingham. First directors are: C. H. Davies, T. Gladdy and T. Reynolds.

ELECTRICAL DEPOSITING PROCESSES, LTD. (162,100).—Private company. Reg. Dec. 24, capital £2,000 in 5s. shares, to acquire plant for the purpose of depositing or forming metals by chemical, electrical or other processes, &c. First directors are C. V. Brearey, R. E. Rollings, H. Lovelock, H. A. Graves and A. A. Ross. Reg. office: 19a, Coleman-street, E.C.

A. J. MILLER & COMPANY, LTD. (10,791).—Private company. Reg. in Edinburgh. Dec. 1, capital £6,000 in £1 shares (4,600 participating preference), to carry on the business of engineers, machinists, electricians, &c. First directors are J. Jamieson, I. Gregory and A. J. Miller. Reg. office: Broughton Market, Edinburgh.

NOYES, STOCKWELL & COMPANY, LTD. (161,582).—Private company Reg. Dec. 12. Capital £5,000 in £1 shares. To carry on the business of merchants, importers and exporters, general traders, electricians manufacturers of electrical and aerial accessories, &c. First directors, are: C. R. F. Noyes, A. Z. Stockwell and L. R. B. Graham. Reg. office: 43-44, Lennox House, Norfolk-street, Strand, W.C.

WELLS, RAYNER & CO. (1919), LTD. (161,174)—Private company. Reg. Dec. 1, capital £2,000 in £1 shares, to carry on the business of electrical and mechanical engineers, &c. First directors are A. W. McClellan and R. W. Gostick. Reg. office: 56, Paddington-street, Marylebone, W.

Prices of Metals, Chemicals, &c.

TUESDAY, Jan. 6

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£126 0 0	£6 0 0	—
Electro Wirebars...	,,	£128 0 0	£7 0 0	—
H.C. wire basis......	per lb.	1s. 5¼d.	$\frac{13}{16}$d.	—
Sheet	,,	1s. 6d.	1½d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 9¼d.	$\frac{13}{16}$d.	—
Brass 60/40—				
Rod, basis	,,	1s. 0¼	—	⅜d.
Sheet, basis	,,	1s. 3⅜d.	¾d.	—
Wire, basis	,,	1s. 3¼d.	¾d.	—
Iron—				
Cleveland Warrants	per ton	£8 4 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£34 10 0	—	—
Lead Pig—				
English	,,	48 10 0	£2 0 0	—
Foreign or colonial	,,	47 10 0	£1 17 6	—
Tin—Ingot	,,	365 10 0	£27 10 0	—
Wire, basis	per lb.	0 4 5	3¾d.	—

Salammoniac.—Per cwt. 95s. and 90s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals)—Per ton £72.

Carbon Bisulphide.—Per ton £56.

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate—Per lb. 6d.

Shellac.—T.N. Orange, 820s.

Rubber.—Para fine, 2s. 7¼d.; plantation 1st. latex 2s. 10¼d. lb.

The metal prices are supplied by the British Insulated & Helsby Cable, Ltd and the rubber figures by W T Henley's Telegraph Works, Company.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Jan. 6, 1883.]

"GLOW" LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to call Mr. Munro's attention to the following definition of "glow," taken from the "Imperial Dictionary": "To shine with intense heat, or, perhaps, more correctly, to shine with a white heat, to exhibit incandescence. Hence, in a more general sense, to shine with a bright lustre," and to ask him if this is not exactly applicable to a carbon filament in a Swan lamp raised to a state of intense incandescence by a current of electricity?

"Incandescence," as a scientific term applied to a certain effect of heat, must, of course, hold its own; but "glow," as a popular term applied to this new and beautiful light, is prettier, and I venture to think more acceptable. "Gluhlampe" is already in general use in Germany.—Yours, &c., W. H. PREECE.

Dec. 30, 1882.

EASTERN ELECTRIC LIGHT & POWER COMPANY.—Mr. Walter Jackson has been appointed secretary of this company.

POSTS AND TELEGRAPHS IN VICTORIA.—The revenue derived by the colony of Victoria during 1882 from the postal and telegraphic services amounted to £312,000, or an increase of £27,000 over the revenue from the same sources in 1881.

THE FERRANTI DYNAMO MACHINE.—We are informed that the Australasian Electric Light & Power Company have taken the sole agency for the Ferranti dynamo-electric machine in the Australias, and the first machine will be sent out shortly.

ELECTRIC LIGHTING COMPANIES' CAPITAL.—The "Journal of Gas Lighting" says that at the end of last year (1882) "the nominal capital of the various registered electric lighting companies amounted to £24,895,500; of which, however, not quite three millions sterling appear to have been actually paid up by the public."

MR. SWAN.—Mr. J. W. Swan, the inventor of the incandescent lamp so well known by his name, is about to take up his abode permanently near London, instead of Newcastle-on-Tyne, this migration being occasioned by the pressing claims which the Swan United Electric Light Company's business has upon Mr. Swan's time.

HONOURS FOR AN ELECTRICIAN.—Herr Bunsen, the celebrated inventor of the Bunsen battery, has been elected a Foreign Associate of the Academy of Sciences, Paris. There are but eight such associates, of whom Sir William Thomson is the only one besides Herr Bunsen whose name can be said to be connected with electrical science.

ELECTRIC LIGHTING FOR TRAINS.—A telegram, dated Vienna, December 31, which appeared in a daily contemporary, says: "Experiments have recently been made for the application of the electric light to the trains of the Southern Railway of Austria, and in a few days the first electrically lighted train will be run from Vienna to Neusuadt."

ROUNDABOUT TELEGRAPHY.—At a recent meeting of the Falkirk Town Council, Councillor Allan directed attention to the delays in telegraphing from Falkirk to Glasgow, and also to Grangemouth, on account of Falkirk not having any direct communication with these places. At present a message can be sent quicker by rail to Grangemouth than by telegraph, because a telegram is first sent to Edinburgh, then re-transmitted to Glasgow, and ultimately sent direct from Glasgow to Grangemouth. In the same way all telegraphic messages to and from Glasgow have to be sent first to Edinburgh and re-transmitted. It was unanimously resolved to memorialise the Postmaster-General, requesting that Falkirk should be placed in direct telegraphic communication with both Grangemouth and Glasgow.

THE ELECTRIC LIGHT AND TEXTILE MANUFACTURERS.—The Mayor and Corporation of Leicester and the leading manufacturers visited the hosiery manufactory of Messrs. Coran, Sons & Cooper, Leicester, last week to witness the first introduction of the electric light into a textile factory in the town. The many shades of yarns used in ladies' jerseys and other fancy fabrics make it difficult to manufacture and make up these goods by gas light; but on this occasion it was proved that the colours undistinguishable by gas light were easily matched by the electric light. The Brush arc and Swan incandescent lamps are used. Leicester is not the first town by any means where this fact has been ascertained, and many textile manufacturers and dyers have adopted the electric light, including the well-known Messrs. Fuller, of Perth.

ELECTRIC LIGHTING BY ACCUMULATORS.—The offices of Messrs. Foster & Braithwaite, 27, Austin-friars, E.C., are now lighted by means of Lane-Fox incandescent lamps, fitted on the gas standards originally in use. The number of lamps employed at present is 24, of 20 c.p. each; it is intended, however, to increase this number to 30. The current is supplied by 25 Faure-Sellon-Volckmar accumulators, constructed by the Electrical Power Storage Company, of Great Winchester Street-buildings, E.C. These are fitted up in the cellar beneath the offices, and are charged by means of a small No. 2 Brush dynamo machine, driven by a 1 H.P. Otto gas engine erected in the same cellar. According to the representative of the Electrical Power Storage Company, the E.M.F. of each of these cells is 2·15 volts, whilst they give a current equal to 800 ampere-hours when fully charged. The installation is a complete one of its kind, and includes all necessary switches, each light being readily turned off or on independently of the others, and one of Ayrton and Perry's ammeters. The lamps gave a very steady and good light when we saw them on Wednesday evening, and altogether the installation seems to have been carefully carried out. There appears to be a consensus of opinion amongst Messrs. Foster and Braithwaite's employees in favour of the new light over that of gas, mainly on account of the increased purity of the atmosphere in which they have to work.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,174. [Vol. LXXXIV. No. 3.] FRIDAY, JANUARY 16, 1920. PRICE SIXPENCE. By Post, 7d. Abroad, 9d.

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Notes.

The Coal Rebate and Electricity Supply.

WHEN the Government first announced a reduction in the price of coal employed for domestic purposes, with the corollary that this reduction would also apply to coal used in generating electricity for those purposes, we pointed out that, to the supply engineer at any rate, this autocratic attempt to reduce the cost of living would bring with it difficulties which would go far to outweigh any possible advantages. For the problem is not so simple as it appears at first sight. It is, indeed, not economically sound to allow a reduction equivalent to the 10s. rebate to the lighting consumer for the obvious reasons that the price of coal is not the only factor determining the price of electricity to the consumer and that in areas where the power load is very much greater than the lighting load the effect of the reduction might even tend to increase the cost of the latter supply. However, economics have not been allowed to affect the question, and the Coal Controller has ordained that where any coal is supplied to an electricity undertaking at the reduced domestic rate that reduction must be passed on to the lighting consumer in the form of a rebate. The way in which this is to be done is indicated in what is called a "prescription," but, like prescriptions of other kinds, it is not distinguished by any great intelligibility, and it has, therefore, been necessary for the Committee under the chairmanship of Mr. ROGER T. SMITH, appointed to consider the question, to issue an explanatory memorandum showing in more detail how the rebate is to be deducted.

Why a Slide Rule Will Be Necessary.

BRIEFLY, the arrangement is as follows: To obtain the rebate in pounds sterling for electricity supplied for domestic purposes during December, 1919, the factor given by dividing the units consumed for domestic purposes during the third quarter in 1919 by the units consumed for all purposes during the same period is multiplied by the total coal in tons delivered during December, 1919, and by 0·5. For the quarter ending March, 1920, the rebate will be based on a factor obtained by dividing the units sold for domestic purposes during the fourth quarter of 1919 by the units sold for all purposes during that quarter: and in subsequent quarters of 1920 the factor will be obtained by dividing the units sold for lighting or domestic purposes during the corresponding quarter in 1919 by the units sold for all purposes during the same quarter. It is not very simple, but it is, perhaps, not so difficult as it sounds. To pass this rebate on to the consumer in the March quarter of 1920 the factor obtained by dividing the total coal in tons used in the fourth quarter of 1919 by the total units sold in the same quarter is to be multiplied by 114d., which is the rebate in pence, less 5 per cent. This will give the rebate in pence per unit—*i.e.*, for the three months January, February, March, 1920, each unit sold will receive a rebate in pence equal to 114d., multiplied by this factor. This amount will be deducted from the consumer's account. In subsequent quarters of 1920 the factor will be obtained by dividing the coal in tons used in the previous quarter by the total units sold in that quarter and multiplying by 114d. To allow for errors in calculation, of which there will probably be a few, deficiencies or surplus in the rebate passed on may be carried on to the next quarter, it being the intention that only the rebate actually received for the coal less 5 per cent. for expenses should be passed on. We expect that as a result of this pronouncement the purchase of calculating machines and slide rules by electricity departments will largely increase.

A Bad Principle.

APART from this, however, the principle involved in the "prescription" is one which we do not wish to see extended. It forms another example of control or interference with industry, and the time is now past when such control can operate with any advantage. The effect which the enforced reduction in the price of coal for domestic purposes is having on the supply of that commodity is by no means what was expected by the authorities, and is just what was expected by everyone else—if we are to judge by the reports which we have received from various parts of the country. These reports show that there is a great shortage in many districts, and that there is a suspicion, which we are bound to say is not confirmed, that the coal merchants are diverting the coal from the home to the export market. While, moreover, electricity consumers, as electricity consumers, will no doubt rejoice that they are about to receive some reduction in the present high prices, it remains to be seen whether their satisfaction will not be short-lived. Any undertaking can obtain authority under the Statutory Undertakings (Increase of Charges) Act to increase the price charged per unit, and, if it does so, this increase is much more likely to be permanent than the Coal Controller's rebate. In areas where the power load is considerably greater than the lighting load, a movement in this direction may not be necessary, but we expect to see applications for permission to increase their rates from a number of the smaller undertakings. As we go to press it is announced that the price of coal is to be raised 2s. per ton to allow for the increased railway rates, so that the value of the rebate is already beginning to fall.

Moulders' Strike.

Once again the moulders have overthrown their executive, for a ballot taken among the members of the three unions concerned to determine whether the proposal to increase the wages by five shillings a week, which was made jointly by the Engineering Employers' Federation and the executive of the three unions concerned, has resulted in favour of a rejection of the proposal and of a continuance of the strike. Fortunately, this result has not made either Sir Allan Smith or Mr. Arthur Henderson less anxious to bring about an *entente*, so that while for the present the engineering trade must continue to bear as equanimously as possible the loss of trade resulting from the continued cessation of production in the foundries of the country, we are still not hopeless that some satisfactory agreement will be arrived at. On Monday the representatives of the employers and moulders met at York, and determined to call a conference of delegates from each branch to place before them the result of the negotiations up to date. This conference met at Manchester yesterday, but the result was not known at the time we went to press. From the strikers' point of view, it may already be said that the strike has failed. Up to now they have so far gained nothing which could not have been obtained by arbitration: their funds are exhausted, and, whatever is the result of the present conference, it is extremely likely that more and more men will return to work. The movement has already begun, and will gather way as time goes on. In this connection the proposal of the Rugby Joint Strike Committee is interesting that a fresh ballot should be taken on the question of resuming work on the terms suggested by the joint conference, providing a Court of Inquiry is appointed to examine the working conditions in foundries and the profits made in the industry since August, 1914, and on the undertaking that on the results of the inquiry the Court should adjudicate as to the justification of the men's demands for a 15s. per week advance. It looks rather like an attempt to cloud the issue by introducing new bases of argument. The real difficulty from the employers' point of view is that to increase the moulders' wages above the five shillings per week suggested would be to admit that more can be gained by striking than by arbitration. Such an admission would, of course, be most unwise, and we are glad to see a strong attitude has been taken up on this point.

Difficulties of the Moulders' Position.

However, this is no time for recrimination, and whatever we may think of the merits or demerits of the moulders' demands, we cannot but admire their determination, whilst their clean method of fighting must command itself even to those who are in opposition to them. Surprise has been expressed in some quarters at the absence of sympathetic strikes, but when it is realised that the moulders were fighting principally to improve their status in the industrial world, it is obvious that the sympathy of the other craftsmen would be tempered by personal apprehensions. As far as the other unions were concerned it was indeed a question of a striving for status rather than for increased wages. Now the moulder has been described as the "Cinderella" of the engineering industry, and it is just what he is. Indispensable and a skilled craftsman, the fact remains that, in the eyes of the mechanic, he is regarded as an inferior. The result is few engineering apprentices undergo a foundry course, and consequently not many works managers have a practical knowledge of foundry work, and are therefore absolutely dependent upon the experience of the foreman of the foundry. The latter is, therefore, the most autocratic of all the departmental foremen. Yet these men have never taken advantage of this power which is at least a testimony to their restraint. The moulder is, moreover, conservative, and holds aloof from anything which, in his opinion, does not directly concern him. The foundrymen, until a few years ago were strictly clannish, but the introduction of moulding machines led to the opening up of the foundry to unskilled labour, a fact which has had its effect upon the insular prejudices of the moulder. He realises now that he must march with the times. He realises also that status engenders respect, and so he is determined to raise his status and establish himself definitely amongst the other skilled craftsmen. It is, we think, these facts which are at the back of the new demands.

Electricity in Housing.

In our Editorial Notes last week we called attention to the fact that the advantages derivable from the use of electricity in the home were at last becoming patent to the public at large, owing to the way in which this use assists in reducing the necessary domestic labour to a minimum. We are, however, afraid that these advantages are not so patent as they should be to those whose business it is to educate the public, either by profound dicta enunciated through the columns of the newspapers, or by means of advertisement, leaflet, poster or other form of propaganda. Housing is very much to the fore at the present time. The "Daily Mail" recently held a competition for the best design of house suitable to modern needs, when the servant is a rare bird and labour-saving is therefore the cry. "The Times" published a housing supplement last week, in which every phase of the legislative, productive and labour side of the problem of how to erect houses as quickly and cheaply as possible is adequately reviewed, and, as is the custom on these occasions, as much information is conveyed through the advertisement pages as through the letterpress of the editorial columns. We say that every phase of the problem is reviewed, but this statement requires modification. We find very little mention of electric lighting, nor of electric heating and cooking either, except in all three cases on the page devoted to the very excellent advertisement of the British Commercial Gas Association and in two advertisements of country house electric lighting plant! Something seems to be wrong somewhere. Either those responsible for the preparation of this Supplement did not approach electrical engineers and the various representative associations of our profession with an offer of space, or those same associations and firms were approached and refused the offer. In either event, there seems to be a singular lack of enterprise in this failure to recognise the greatness of this opportunity for showing the part that electricity can and should play in the solution of the housing problem. We have a good case, but we must advertise its value, and not leave our propaganda work to be carried out by the gas interests, or let it be thought that electric lighting, while it may be flourishing in the country, is not suitable for town use. Yet Macaulay's New Zealander or Mr. Wells' Martian might legitimately make this deduction if he were handed this Housing Supplement for perusal.

An Example of Short-sighted Obstruction.

The Appointments Department of the Ministry of Labour was perhaps unjustly held up to ridicule in the statement that the only appointments it was able to fill were vacancies on its own staff. It will be recalled that this department was inaugurated to find work and provide training facilities for men of what is called the officer class—*i.e.*, those whose education or training would potentially fit them for some superior commercial position, irrespective of what their military rank was. Though we do not wish to argue that the Appointments Department has done all that it could have done in this direction, we may perhaps call attention to some of the difficulties it has had to face, especially in so far as obtaining appointments for men in engineering works is concerned. It will be remembered that one of the principal duties of the department was the provision of a training grant to men who, when war broke out, were about to start their professional or commercial career. For these men the five years of war was as if that period had suddenly been added to their age, and as if much of their bodily strength had been simultaneously wrested from them. A scheme for training these men at State expense in one or other of the professions was, therefore, inaugurated. This scheme has, we understand, been successful in some cases; but in the engineering trades the trade unions have prevented its fulfilment by taking up a very non-possumus attitude on the grounds that the trainees under the appointment scheme would eventually fill the better positions in the industry to which the ordinary industrial apprentices aspire, that many industrial apprentices were still with the colours, that many trade unionists were out of work, and that, finally, the scheme would militarise the factories. Putting on one side for a moment the absurdity of the last reason, it would seem that trade unions consider that a man who has fought for his country in the field is entitled to less consideration than one who has stayed at home. In our opinion, everybody who did war work should be treated equally, but, if there is to be any preference, we feel most strongly that it should be in favour of those who endangered their lifes and suffered deprivation of health. We very much deprecate this attitude of the trade unionists, and we are sorry that the Ministry of Labour has had to modify its plans on account of the attitude which has been taken up. It is now proposed, except in the case of the disabled, to consider no engineer candidates for grants who previously to their war services had entered upon civil careers in any trade or profession other than engineering, and that, in order to ensure that no trade union principles are infringed, the latter shall be represented on the interviewing boards, who will select candidates. At a time when engineering progress is most essential in the interests of the country, it is a pity that the number of likely recruits to its ranks should be artificially cut down in this way. There seems no limit to the wrong-headedness which some trade organisations will take up, and we hope in this case at least they will reconsider their attitude.

Current Topics.

Subjects of interest dealt with in the current issue include the following:—

Mr. D. C. Gall contributes an article on page 54 on "The Artificial Track Circuit," in which the principle of an instrument for testing track circuits, recently designed by him for Messrs. Tinsley & Company is described.

On page 60 Mr. F. R. Parsons contributes an article on "The Principles and Functions of Condensing," which is intended to supplement the scanty information available on the theoretical aspects of condenser practice.

We continue our account of the Electrification of the Melbourne Suburban Railways on page 55. The present instalment deals with the electrical features of the rolling stock and the overhead equipment.

On page 61 we give the first part of an abstract of a Paper on "Failures of Turbo-Generators and Suggestions for Improvement," read by Mr. J. Shepherd before the Institution of Electrical Engineers. This classifies the failures of this type of machine under mechanical weakness, electrical weakness, heating and fire risk, ventilation difficulties, and deals with certain aspects of each in turn.

In our Leading Article on page 67 we comment on certain phases of this interesting problem, especially with regard to the questions of solid versus built-up rotors and of cooling.

On page 59 we give an account of a Paper read by Mr. E. C. de Segundo before the Society of Technical Engineers on "The Proper Position of the Engineer in Industrial and Political Circles."

On page 63 we give the first part of an account of the instruments shown at the Exhibition organised by the Physical Society of London and the Optical Society.

An abstract of the more important changes in the patent law effected by the Patents and Designs Act of 1919 are given on page 71.

Particulars of the principal electricity supply Bills of the Parliamentary session, 1920, are set out on page 68.

Arrangements for the Week.

FRIDAY, Jan. 16th (to-day).

BATTI-WALLAH'S SOCIETY.

6 p.m. At the Victoria Mansions Restaurant, Victoria-street, Westminster, London, S.W. Special General Meeting.

INSTITUTION OF CIVIL ENGINEERS—STUDENTS' MEETING.

6 p.m. At Great George-street, London, S.W. Vernon-Harcourt Lecture on "The Economic Requirements for Inland Navigation Transport in the British Isles," by Mr. R. B. Dunwoody.

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' MEETING.

7 p.m. At the City and Guilds (Eng.) College, South Kensington, London, S.W. Paper to be read on "The Development of Automatic Telephony," by Mr. J. H. Reyner.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Chairman's Address on "Meteorology and Engineering," by Mr. B. E. Dunbar Kilburn.

PAISLEY ASSOCIATION OF ELECTRICAL ENGINEERS.

7.30 p.m. At the Technical College, George-street, Paisley. Paper on "Electricity and Matter," by Mr. A. M'Lean, B.Sc.

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, Piccadilly, London, W. Discourse on "Low Temperature Studies," by Prof. Sir James Dewar, F.R.S.

MONDAY, Jan. 19th.

INSTITUTION OF ELECTRICAL ENGINEERS—LIVERPOOL SUB-CENTRE.

5.30 p.m. At the Engineering Theatre, the University, Liverpool. Lecture on "The Application of Electric Power on Board Ship," by Mr. C. H. Wordingham, C.B.E.

7 p.m. At the Lecture Theatre, Laboratories of Applied Electricity, the University, Liverpool. Addresses by Messrs. R. T. Smith, C. H. Wordingham, C.B.E., and J. A. Robertson. Chairman's Address will be delivered by Prof. E. W. Marchant, D.Sc.

INSTITUTION OF ELECTRICAL ENGINEERS—INFORMAL MEETING.

7 p.m. At the Rooms of the Chartered Institute of Patent Agents, Staple Inn Buildings, London, W.C. Discussion on "The Functions of a Trade Journal," opened by Mr. F. H. Masters, O.B.E.

TUESDAY, Jan. 20th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, London, W. Lecture on "Modern Development of the Miner's Safety Lamp," by Sir John Cadman, K.C.M.G. (Lecture I.)

INSTITUTION OF ELECTRICAL ENGINEERS—NORTH-WESTERN STUDENTS' CENTRE.

7.30 p.m. At Houldsworth Hall, Deansgate, Manchester. Paper on "Wireless Receiving Stations," by Mr. J. Scott-Taggart.

INSTITUTE OF METALS—BIRMINGHAM LOCAL SECTION.

7.30 p.m. At the Chamber of Commerce Buildings, New-street, Birmingham. Paper on "Season Cracking," by Dr. W. H. Hatfield.

THURSDAY, Jan. 22nd.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Transformers for Electric Furnaces," by Mr. J. L. Thompson.

FRIDAY, Jan. 23rd

PHYSICAL SOCIETY.

5 p.m. At the City and Guilds Technical College, Leonard-street, Finsbury, London, E.C. Papers to be read: "On Maintained Oscillations in Triode Valve Circuits," by Dr. J. H. Vincent; "Measurements of the Chief Parameters of Triode Valves," by Dr. W. Eccles; "Measurement of Amplification of a Radio-Frequency Amplifier," by Mr. F. W. Jordan, B.Sc.; "On the Measurement of Amplifications given by Triode Amplifiers at Audible and at Radio Frequencies," by Mr. F. E. Smith, F.R.S. Exhibition of a Method of Determining the Hardening Temperature of Steel, by the Hon. C. W. Stopford and Mr. C. R. Darling; and an Exhibition of a Thermal Cell of Constant Voltage, by Mr. C. R. Darling.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "Recent Advances in Utilisation of Water Power," by Mr. E. M. Bergstrom.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecture on "Evaporation in the Chemical Industry," by Mr. J. A. Reavell.

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, London, W. Discourse on "Researches at High Pressures and Temperatures," by the Hon. Sir Charles Parsons, K.C.B., F.R.S.

An Artificial "Track Circuit."

By D. C. GALL.

The extensive use of the track-circuit in railway signalling, and the refinements and efficiency of modern design in this respect has made the need for an artificial track circuit which will faithfully represent the electrical properties possessed by the real one, greatly felt, for research purposes and for testing apparatus to be used in conjunction with track-circuits.

The real track-circuit is formed by isolating a section of the running rails, which are made part of a relay circuit so arranged that auxiliary circuits operating signals, &c., are controlled by the presence of a train in the section, through the shunting effect of the wheels. There are two quantities which affect the track-circuit electrically. These are the rail-impedance, and the ballast-admittance, and unless the artificial track-circuit is capable of representing a large range in these circuit constants, its application must be limited. To be of the greatest use the apparatus must be such that it can be set to represent any electrical condition which might occur for any value of rail-impedance or ballast-admittance.

Electrically any section of the running rails consist of two conductors of low impedance between which is distributed admittance of a very variable value. If the distribution of the admittance (due to ballast sleepers, &c.) is taken as symmetrical, such a circuit can be represented in the form shown in Fig. 1. If Z_r is the rail-impedence and Y_B the ballast admittance, then the value of the series impedance Z and the two shunt impedances Z_1, in the equivalent circuit will be

$$Z = \tfrac{1}{2}\sqrt{\frac{Z_r}{Y_B}}\left(\varepsilon^{\sqrt{Z_rY_B}} - \varepsilon^{-\sqrt{Z_rY_B}}\right).$$

and
$$Z_1 = \frac{2 - \varepsilon^{\sqrt{Z_rY_B}} - \varepsilon^{-\sqrt{Z_rY_B}}}{\sqrt{\frac{Y_B}{Z_r}}\left(\varepsilon^{\sqrt{Z_rY_B}} - \varepsilon^{-\sqrt{Z_rY_B}}\right)}.$$

It is obvious that it is only necessary to construct a piece of apparatus in the form of figure (1) where the values of Z and Z_1 can be varied to whatever are required, and the conditions of a track-circuit with symmetrical distribution of ballast-admittance between rails of uniform impedance will be realised. Such a result can be achieved with four switch dials, each with a number of studs whereby the four components of the branches of the circuit can be regulated. One dial for the resistance of Z, one for the reactance of Z, one for the resistance of the two Z_1 branches, and a fourth for the reactance of the two Z_1 branches. The disadvantage of this arrangement is the necessity for calculating the values of Z and Z_1 for every combination of Z_r and Y_B, since the setting is not direct in values of the rail constants.

For exact representation of the theoretical circuit for laboratory use this form is not without advantages, but since the assumption of symmetry is not likely to be true, great refinements of accuracy are irrational, and further since the final conditions in which any track-circuit apparatus must work, are themselves very unstable, absolute accuracy of representation, cannot be more than momentary.

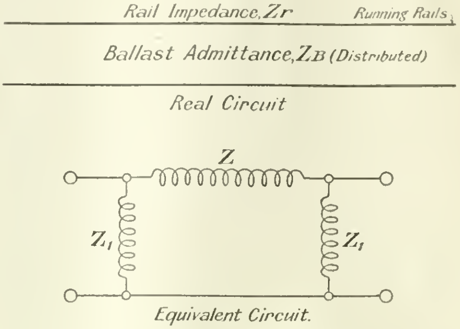


Fig. 1.

Expanding the value of Z gives

$$Z = Z_r + \frac{Z_r^2Y_B}{6} + \frac{Z_r^3Y_B^2}{120} \cdot \;\ldots\; .$$

And
$$Z_1 = \frac{2}{Y_B} + \frac{Z_r}{6} - \frac{Z_r^2Y_B}{360} + \frac{Z_r^3Y_B^2}{15{,}120} \cdot \;\ldots\; .$$

So that approximately the impedances of the two parts of the equivalent circuit are given by

$$Z = Z_r.$$

And
$$Z_1 = \frac{2}{Y_B} + \frac{Z_r}{6}.$$

Since Z_r and Y_B are never large both expressions are probably as exact as actual conditions conform to the known values of Z_r and Y_B.

The components of $\qquad Z_1 = r_r - jx_r$

where r_r is the rail-resistance and x_r the rail-reactance at any particular frequency.

The components of

$$Z_1 = \frac{2}{Y_B} + \frac{r_r}{6} - j\frac{x_r}{6}.$$

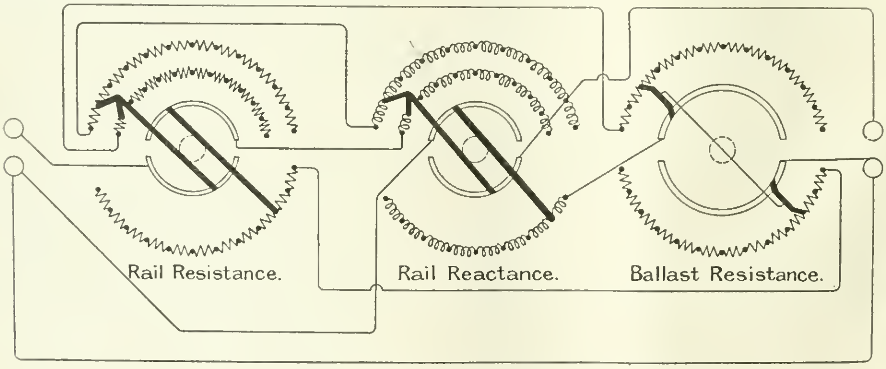


Fig. 2.—Direct-Reading Artificial Track Circuit. (H. Tinsley & Co.)

Y_B is practically non-inductive, and if r_B is ballast resistance

$$Z_1=\left(2r_B+\frac{r_r}{6}\right)-j\frac{x_r}{6}.$$

By using these approximations it is possible to construct an artificial track-circuit which will read direct on its dials in the values of rail-resistance, rail-reactance (at some stated frequency) and ballast resistance.

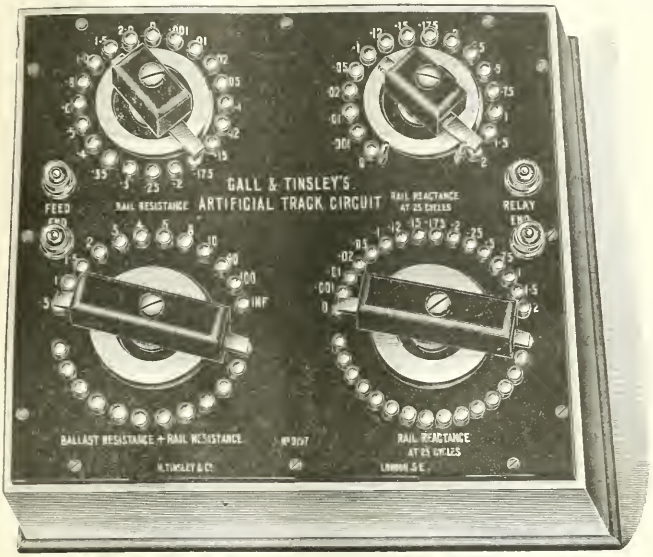


Fig. 3.

The first dial labelled rail resistance puts in various values of the rail-resistance r_r in the series impedance Z (Fig. 2) and values of $r_r/6$ in each of the shunt branches of Z_1. The second dial labelled rail-reactance puts in reactance x_r in a similar manner in series and again $x_r/6$ in each shunt branch. The third dial puts in the values of the ballast resistance in each shunt branch. For continuous current only, the middle dial may be omitted.

Messrs. H. Tinsley & Company have added this piece of apparatus to the already long list of Scientific Instruments manufactured by them, and (Fig. 3) is an illustration of the four dial type for research purposes, having a range of rail-resistance 0·001 – 2 ohms, rail-reactance (at 25 cycles), 0·001 – 2 ohms, ballast resistance 0·5 – 100 ohms, thus covering the extremes to be met with in practice. To test the behaviour of any type of track apparatus the whole arrangement can be fitted up in the laboratory with the artificial track-circuit set, to any value of rail-impedance and ballast-admittance, and the effect of a "train-shunt" investigated at either end of the track. Further the effect of variations in the ballast (such as occur with the change of weather) upon shunting-effect and failure, can be investigated with facilities impossible to approach upon the actual site.

A further application of the artificial track-circuit of this type is to the measurement of the rail constants upon the actual track-circuit. This can be done by making the artificial track-circuit one arm of a bridge, and balancing the real track-circuit in the other on load, no-load and short-circuit, reading the circuit values direct from the dials.

The Electrification of the Melbourne Suburban Railways.

Interesting Application of the H.T. Direct-Current System.

(*Continued from page 34.*)

The Rolling Stock.

The trains are operated on the "multiple unit" system. In the case of Melbourne, while it was at one time intended to make up each "unit" of a motor car and a trailer, both equipped for driving from one end, only a limited number of trailer cars have, for the present, been equipped with driving apparatus. The normal six-car train has a motor car at each end, with a third motor car about the centre of the train. No special type of car has been designed for Melbourne, the existing rolling stock being as a rule utilised. Some 45 per cent. of the rolling stock will consist of compartment cars with swing doors, the remainder being of a combination type, having sliding doors and cross-seats, with a corridor. Most of these cars are partitioned into smoking and non-smoking compartments.

As no new swing door cars are being constructed for the electric lines, the bodies of the existing cars are being transferred to new underframes and bogies of a type uniform with those used in the sliding door cars. Some of the sliding door trailer cars have also been running in the steam service, but new sliding door motor cars are being constructed for the electric service. Fig. 5 shows a six-car train of the sliding door type. The swing door cars are very similar to those used on British railways. The sliding door cars have a centre passage way throughout, but no vestibule, so that it is not possible for passengers to pass from one car to another. The body framing of the new cars is of teak, but Australian woods have been used wherever possible, the interior being finished in Queensland maple. The seats in the first class cars are covered with green Australian leather; those in the second class with brown duck cushions. The whole of the rolling stock has been built in the State railway workshops at Newport. Fig. 4 shows the wiring arrangements on the car.

Electric Equipment on the Motor Cars and Pantograph.

Each motor car has four motors of 140 h.p., the gear ratio being so proportioned that the maximum speed will be 52 miles per hour on level tangent track. They are of the G.E. 237 type normally operating at 750 volts. The operation of the motor is shown in Fig. 6. The total pressure of the pantograph on the contact wire is such that with a reasonably clean wire the pantograph is able to collect considerably over 500 amperes, which is the normal maximum operating current for each motor coach, without sparking, from a contact wire 0·25 sq. in. cross-section. The pantograph has a working range between 14 ft. 6 in. and 21 ft. 6 in., the working pressure being maintained by means of springs. The pantograph is brought into and taken out of action by pistons in cylinders mounted on the frame of the collector. Air pressure for the initial operation of the pistons is supplied in the first instance by a hand pump installed in the guard's compartment; the motor pumps can then be started up, and the subsequent air pressure obtained from the main brake reservoir. The pantograph is then controlled by means of two electro-pneumatic valves, which can be operated electrically or by hand. In order to reduce the line voltage to one suitable for the master-controller and other control circuits, a dynamotor is used, consisting of a single field and armature with two

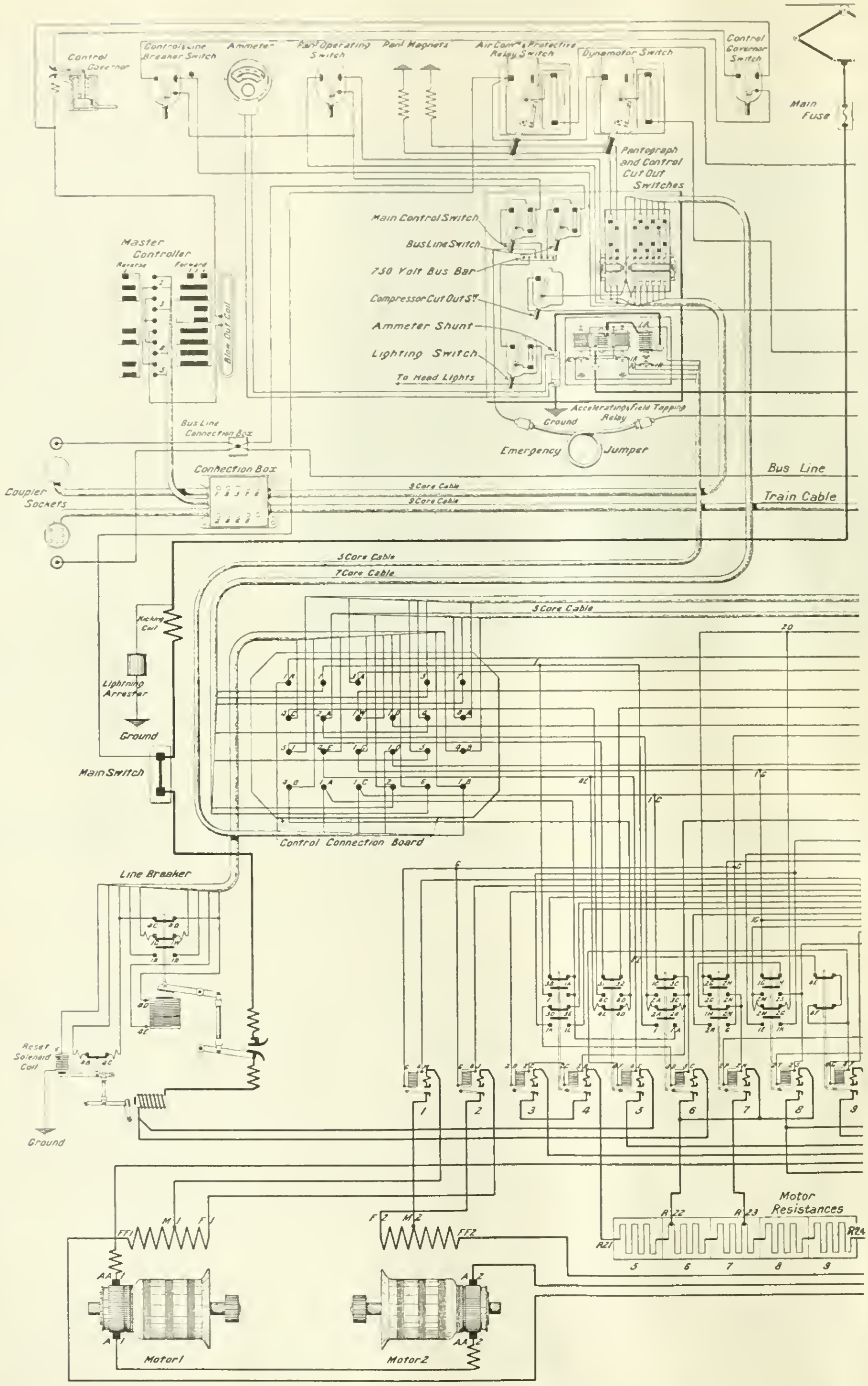
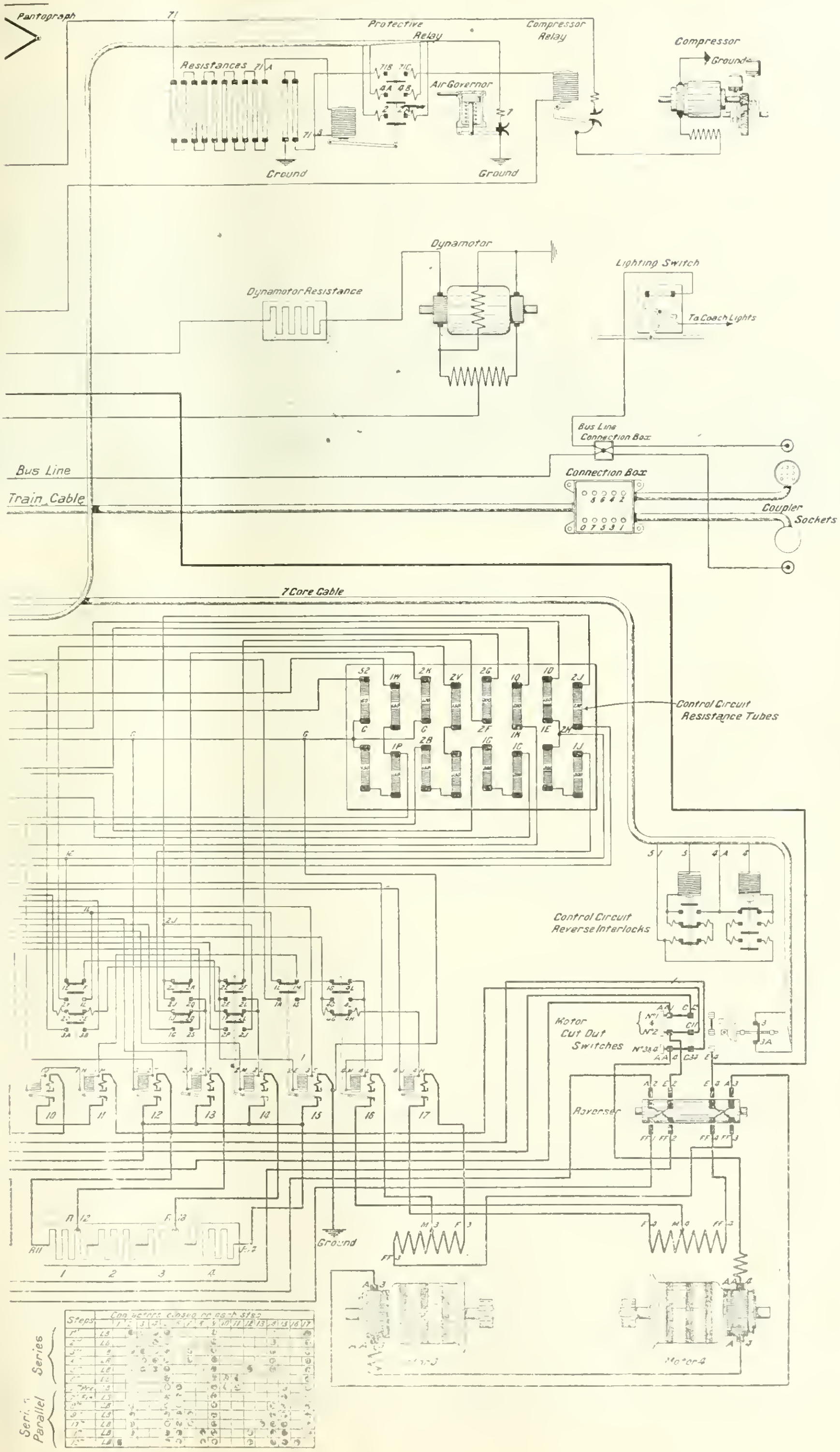


Fig. 4 —Wiring Diagram for Motor Cars.


Pantograph
Resistances
Protective Relay
Compressor Relay
Compressor
Ground
Air Governor
Ground
Ground
Dynamotor
Dynamotor Resistance
Lighting Switch
To Coach Lights
Bus Line Connection Box
Bus Line
Train Cable
Connection Box
Coupler Sockets
7 Core Cable
Control Circuit Resistance Tubes
Control Circuit Reverse Interlocks
Motor Cut Out Switches
Reverser
10
11
12
13
14
15
16
17
Ground
1
2
3
4
Motor 3
Motor 4
Steps
Contactors closed on each step
Series
Series Parallel

identical armature windings and commutators. The master-controller is of standard type, but as the actuation of the contactors is automatic, the controller only has four points in the forward direction and two in the reverse direction, the first point in either direction being known as the "switching" or "lap point," and the second point being the "series" position. The air compressor, governor, emergency and trip valves are of usual type.

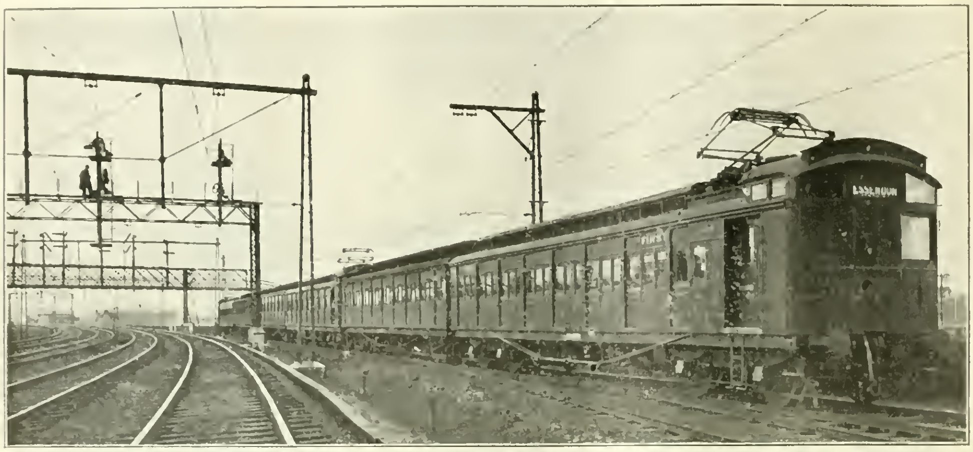


Fig. 5.—View of a Six-car Train used on the Melbourne Suburban Railways.

The Permanent Way.

The Melbourne suburban system consists of approximately 335 track miles, including sidings. Most of the routes are double track, but those from South Yarra to Caulfield and North Melbourne to South Kensington are four-track routes, while for three miles there is a six-track route. The normal permanent way construction is 100 lb. per yard, T-section rail double-spiked to untreated sleepers of hard wood, there being about 15 in. of bluestone ballast. The track gauge is 5 ft. 3 in. with 11 ft. 8 in. centres, while minimum structure clearance above platform level on tangent track is 7 ft. from track centre, increased to 8 ft. on 12-chain curves. The minimum curve is 9 chains radius, while the maximum gradient of any importance is one of 2 per cent. For nine miles between North Melbourne and Broad Meadows the average gradient is 0·85 per cent., the maximum permissible speed on this section being 52 miles per hour. Practically all curves have a 150 ft. easement approach.

Overhead Equipment.

The equipment of the track with overhead contact wires for operation at 1,500 volts was designed to provide the advantages of a flexible construction which would secure the best conditions for current collection by the pantographs on the trains and to maintain the total copper section required per track without auxiliary feeder cables. The cables and overhead equipment for this work were supplied by the British Insulated & Helsby Cables, Ltd. The number of conductors was kept at a minimum, in order to avoid interference with signals, only one catenary wire and one contact wire being employed over each track. The supporting droppers between the catenary cable and contact wire are terminated at the lower end by a short length of chain, so that the tendency of the contact wires to lift under the upward pressure of passing pantographs was not restricted by the weight of the dropper or of the catenary cable to which it was attached at the upper end.

The normal construction on main suburban tracks provides for 0·25 sq. in. hard-drawn grooved copper contact wire supported by flexible droppers at intervals of 15 ft. from a stranded hard-drawn copper cable of 0·25 or 0·375 sq. in. There is thus a minimum equivalent of 0·5 sq. in. section of copper over each track. The contact wire is automatically tensioned at each end of each 3,000 ft. length to approximately 2,500 lb., and is anchored near the centre of every such length. The catenary wire normally has a 10 ft. 9 in. sag at the centre of a 300 ft. span at 60° F., with a minimum tension approximately 3,200 lb.

The normal contact wire height is 16 ft. 6 in. over the main suburban tracks at 70° F., but over level crossings the minimum height is 18 ft., while under low bridges, which are numerous, the minimum height is 14 ft. 6 in. above rail level, giving a vertical clearance of 12 in. between the contact wire collecting surface and the underside of bridge. As the maximum height of the projecting ventilators on the country rolling stock is 14 ft. 2 in., considerable care had to be exercised in erection to preserve the clearances provided in the diagram. The standard contact wire suspension is maintained, but beneath low bridges, and to ensure that the pantograph would not raise the contact wire more than 2 in., a maximum gradient of 1 in 150

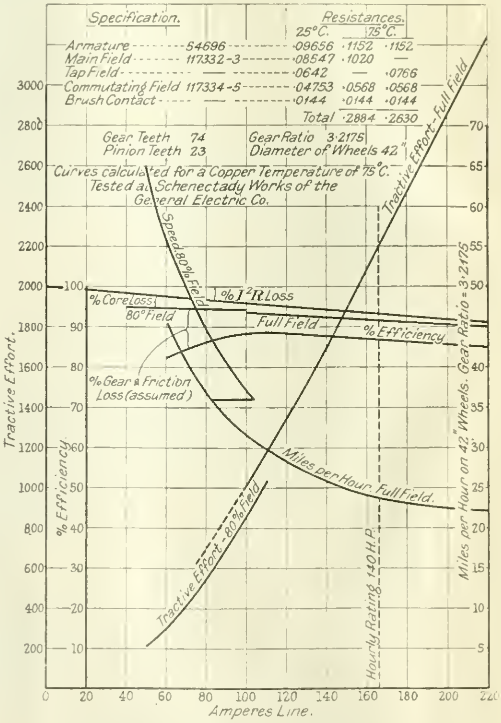


Fig. 6.—Speed-Tractive Effort and Efficiency at 725 Volts G.E. 237-750 Volt Form "A" Railway Motor.

was adopted for the line, and where possible a gradient of 1 in 250 except where speeds were limited. In some cases rigid droppers have also been used. The dropper connections between the catenary and contact wires were measured and cut to a special dropper table, which provides the necessary adjustments to allow for grades; the droppers were then erected in the field with practically no adjustment, and a well-aligned line has been obtained, whose vertical movement responds uniformly to changes of temperature, the catenary wire being stressed well within its elastic limit to provide for this. The importance of this precaution will be realised with temperature limits between 27° F. and 175° F. Where a steam service is also being used, the insulators are arranged so as to avoid the direct blast of the locomotive exhaust. The whole of the fittings were specially designed for the equipments by the consulting engineers in conjunction with the contractors.

(To be concluded.)

The Proper Position of the Engineer in Industrial and Political Circles.*

By E. C. DE SEGUNDO.

The American definition of an engineer is "a man who can do for one dollar what any fool can do for two," and I am not sure that this is not about as good an all-round definition as could be formulated, because it involves all the attributes that are necessary to the "make-up" of a real, live engineer—skill, alertness, individuality and resourcefulness, with the inevitable concomitants, honesty, integrity and high moral character. But you will agree with me that there are a number of so-called engineers—who do *not* possess either the instincts, the ability, or the training which should distinguish the true engineer, and I have long been of opinion that a grave mistake is made by all the combinations of craftsmen, in not insisting, as a necessary qualification for membership, upon a high standard, not only of skill and ability, but of moral character. My deliberate judgment is that the combination of ability and integrity is one of the rarest met with, and my experience is that if a man is honest it is too often because he is too great a fool to be anything else, and, on the other hand, that the man of ability has to be watched like a cat does a mouse because he so seldom possesses that sense of moral responsibility which acts like a sheet-anchor to windward amid the tempest and hidden currents of temptation to abuse his opportunities.

Believe me, we, as a nation, stand to-day in greater and more imminent peril of our national existence than we ever did during the war, and the need for loyalty, co-operation and co-ordination between us all, from the highest to the most humble operative was never more insistent in the whole history of our country. Our late enemies are doing everything in their power to foster discontent in this country between those whose loyal and intelligent co-operation can alone save our Empire from commercial and industrial disaster, ending in financial bankruptcy.

WHAT COMMONSENSE DICTATES.

Commonsense, if nothing else, dictates that the headlong gamble in which we are at present engaged, be arrested; that we should take a sane view of things; that instead of going on trying to get a quart out of a pint pot, we *all* strive as quickly as possible so to arrange our affairs that what we spend is well within what we earn. To do this we must *all*, from the highest to the lowest, make up our minds to work harder and spend less. We must develop our natural resources in the most efficient manner; we must produce goods for export, because, remember, the welfare of a country is necessarily bound up primarily with the extent to which the value of its exports exceeds the value of its imports, and at present we are continuously increasing the amount we owe to people outside our country. If the United States were in a position to say to us "Pay that thou owest" our bank notes would not be worth even the paper upon which they are printed. We are living entirely upon credit, that means, we continue our national existence merely because of the goodwill of our creditors. The fact is—and there is never any useful purpose to be served by shutting our eyes to facts—that, so far as cash resources are concerned this war has bled us white. We must set to with a will to develop the natural resources of the Empire in the greatest measure possible, and under conditions of the greatest efficiency. The so-called "war-profits" made by contractors and others who have supplied the Government simply do not count as a factor in relieving the really serious position of our *external* indebtedness. It merely means that these individuals have accumulated "promises to pay" from the Government which enable them to exchange the bits of paper for motor cars, or fur coats, or diamonds, or other of the wholly senseless forms of extravagance in which so many of us are indulging at the moment in the foolish belief that we have "made money" and that a "man can do what he likes with his own." The *power* to purchase does not necessarily confer the *unlimited right* to purchase, and similarly, the power to extort from others does not confer the *right* to do so. At this juncture in the affairs of the nation, we must be prepared cheerfully to sacrifice our individual power of gain to the requirements of national necessities.

It is therefore clear that we must keep our eyes fixed upon the value of commodities in the international market and order our doings in such wise that we are able to hold our own in these markets. For a few years we may toss about our printed pieces of paper, which only have an exchange value because we believe that *one day* our Government may be able to give cash for them. Turn over in your minds, however, what chances there are of this day ever coming as long as we continue piling up the number of these bits of paper, which are nothing more than "promises to pay"—some time.

THE POSITION OF THE ENGINEER DEPENDS ON HIMSELF.

Let me now revert to the first words of the title of this Paper, "The Proper Position of the Engineer in Industry." Do you not agree with me that the proper position of the engineer will depend entirely upon the position the engineer is qualified to occupy? And will this not depend upon the engineer himself? I am one of those whose experience has taught him that the strongest position a man can obtain is the position he makes for himself. A position which is obtained by influence, or favour, or which is not filled by a man whose capacities and abilities are at least equal to the duties and responsibilities of that position, cannot fail to work harm to the community in the long run. It is on a par with a position gained and sustained by violence. It is necessarily short-lived, because no one can claim a monopoly of violence, and as long as human nature is what it is, what is gained by violence will be invariably lost by the same means. Take the example of Germany—which should be fresh in all our minds. The attempts to impose her will upon the world at large by force did not succeed although, according to all human probabilities, the odds were vastly in her favour. But the injustice of her aims and the monstrous character of the means she adopted aroused a stronger will than hers and, although we do not set up for being saints ourselves, the *right* will won out as it always does in the long run because spiritual forces are far more potent than material forces in the ultimate issue.

Now, what is the proper position of the engineer—assuming that he is of the type I described in the opening portion of my remarks, and is able and willing efficiently to discharge the duties and responsibilities he assumes? Why, not only at the centre of the industrial circle, but along every radius. The engineer, taking the word in its broad sense, is the man who leads the way in civilisation and progress, who not only carves out new directions for industry but provides the brains, the will and the means of turning them to account. What more magnificent field can the engineer wish for than that which opens out before him to-day? In his hands lie the rehabilitation of the world and of its commerce and industry, and speaking of engineers as a body, and as I have found them, I feel sure that they will do the job and do it well, because to engineers Huxley's words apply as forcefully as to any other class of Britisher: "Depend upon it, when a Briton sets his mind to do a thing, he will do it better than anyone else."

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* Abstract of a Paper read before the Society of Technical Engineers.

Power Station Topics.

Principles and Functions of Condensing.

By F. R. PARSONS.

Text-books and works on steam engine practice invariably treat the subject of condensers and condensing apparatus as an abstract proposition, presupposing the power house student to possess a theoretical knowledge of the various elementary problems involved, or by taking up the subject at a point that makes subsequent reasoning difficult, if not impossible. To power station pupils in particular does this apply, and seeing that all modern power generation schemes, be it the older type of reciprocating engine, or the more modern steam turbine, enlist the co-operation of condensing plants in order to secure the last possible degree of efficiency, the principles and functions of condensing represent something very much more than an abstract item in a pupil's education.

This short article is intended to supplement the scant information existing on the theoretical aspects of condenser practice, and to prepare the inquiring mind for a more complete acceptance of the higher technicalities involved.

The Use of a Condenser.

The purpose of a condenser is to bring down the pressure at which an engine exhausts to the atmosphere; in other words, to abstract the vast amount of heat remaining in the steam as it leaves the cylinder, which heat represents potential power. Thus can be obtained an increase of power for the same quantity of steam generated, or, alternatively, a lower expenditure of steam, and consequently of fuel, for the same power output.

From this one will readily see that the lower the temperature at which heat is rejected the greater becomes the efficiency of any heat engine. Or, to express this in a more technical form, the greater the difference between initial absolute temperature of the steam, and its final absolute temperature, whether this is in the form of steam as it leaves the exhaust of an engine direct, or after passing through a condenser, a greater proportion of the total heat units generated become usefully convertible into power.

At atmospheric pressure, or an absolute pressure of 29·92 in. of mercury (barometric), equivalent to 14·7 lb. per square inch, the temperature of steam is 212° F.; hence a non-condensing engine would have to exhaust against this pressure. If, however, we reduce this pressure it is equivalent to lowering the exhaust line of a diagram taken of the functions of steam within the cylinder of an engine. And as every young engineer knows, such lowering of an exhaust line increases the area of a diagram, thus denoting a proportional gain in power without in any way altering the cut-off, or increasing the volume of steam entering the cylinder. The result is a net gain in efficiency proportional to the amount of pressure reduction effected.

The function of a condenser is, therefore, to reduce, as far as practicable, to zero this atmospheric pressure, namely, 14·7 lb. per square inch, which is operating against the exhaust steam as it leaves the engine. In a general way this operation is performed by carrying the steam, as it leaves the exhaust, to a chamber, wherein it is brought in contact with a jet or a spray of cold water, which at once condenses it, and creates a vacuum —in other words, reduces its pressure below that of the atmosphere, thus removing the retarding effect upon the piston's action.

Degrees of Vacuum.

The degree of vacuum, or that state obtainable towards a theoretically perfect vacuum, depends upon (*a*) the temperature of the water which is used to condense the exhaust steam; (*b*) the quantity of water used; (*c*) the absence of air within the condensing apparatus; and (*d*) the mechanical perfection of the air pump bucket, valves, &c.

Now let us look into the functions of a condenser, and learn how and why a vacuum can be created as a result of such condensation. By referring to the tables in text books, on the values and properties of steam, we find that 1 lb. of steam at atmospheric pressure, and with a temperature of 212° F., occupies a volume of 26·79 cubic ft. Now, if we were to condense this to such a point that its temperature falls to 100° F., it would have a negative pressure of 1·93 in. of mercury—that is to say, a vacuum which may be expressed as

$$29{\cdot}92 - 1{\cdot}93 = 27{\cdot}99\,;$$

because, as we have seen, 29·92 in. of mercury represents *absolute* pressure when the temperature of steam is 212° F. Consequently the vacuum created by the fall in temperature—namely, from 212° F. to 100° F.—would, if the reduction had been brought about within a closed vessel having a capacity of exactly 26·79 cubic ft., be recorded on the gauge as 27·99 in. of mercury. This, of course, assumes an absolutely perfect reduction, and ignores altogether the fact that the presence of air with the steam will tend to make such reduction less effective. For it is a well-known fact that air will inevitably be found with the steam in any form of condenser, having gained admittance to the boiler either by way of the feed water, or through an injector, or by reason of its admission through other extraneous causes, such as leaky piston and valve rods, or anywhere in the pipe line between the exhaust valve and the condenser. Hence, it will follow that the less perfect the reduction—that is to say, the greater the quantity of air remaining in the steam when it reaches the condenser—the less perfect will be the vacuum created, and the smaller the amount of economy effected.

Advantages of Condensing.

It is well known that by the addition of a suitable form of condenser to an engine a net gain in efficiency of at least 25 per cent. may reasonably be expected; or, alternatively, such addition would permit a saving of one-quarter of the total quantity of coal consumed per year. It will be interesting to illustrate this point by means of an example, and the present writer can offer no better way of doing this than by quoting from an article which appeared in the "Power User," to which journal he is indebted for the use of this abstract.

We will suppose a single cylinder engine is working with 60 lb. steam pressure per square inch by gauge, the cut-off being arranged to take place at 0·5 of the stroke, the engine exhausting against the atmosphere, or 14·7 lb. pressure per square inch absolute. The diagram factor for this cylinder may be taken at 0·87, the clearance volume being neglected. As the cut-off takes place at half-stroke the ratio of expansion is 2, and the steam pressure by gauge 60 lb. per square inch, obviously the absolute initial pressure of steam is 60 + 14·7, that is to say, 74·7 lb. per square inch.

Let M.E.P. = the mean effective pressure in the cylinder, then

$$\text{M.E.P.} = 0{\cdot}87\left(74{\cdot}7\,\frac{1+\log_e 2}{2} - 14{\cdot}7\right),$$

$$= 0{\cdot}87\left(74{\cdot}7\,\frac{1+0{\cdot}6931}{2} - 14{\cdot}7\right),$$

$$= 42{\cdot}1.$$

If, now, a condenser were fitted to this engine so that the pressure against which it exhausts is 2 lb. absolute—that is, it exhausts into a vacuum of 25·8 in.—then the new mean effective pressure would be

$$\text{M.E.P.} = 0{\cdot}87\left(74{\cdot}7\,\frac{1+\log_e 2}{2} - 2\right),$$

$$= 0{\cdot}87\left(74{\cdot}7\,\frac{1+0{\cdot}6391}{2} - 2\right),$$

$$= 53{\cdot}2.$$

The difference between these two figures is

$$53\cdot2-42\cdot1=11\cdot1,$$

and the percentage increase in power over the non-condensing engine would be

$$\frac{11\cdot1}{42\cdot1}\times100=26\cdot4 \text{ per cent.}$$

Therefore, if this engine were of such dimensions that the power when working non-condensing was 100 I.H.P., after the condenser was fitted it would develop 126·4 I.H.P. Moreover, if in the first instance it required 3·5 lb. of coal per indicated horse-power, in the second case a horse-power would be developed for

$$\frac{3\cdot5100}{126\cdot4}=2\cdot77 \text{ lb. of coal.}$$

From this we see that the advantages of a condenser are beyond dispute. But against any increment thus accrued in the way of power, must, of course, be debited the power necessary to operate the condensing plant; but generally from 3 to 5 per cent. represents an ample margin for this contingency.

Failures of Turbo-Generators and Suggestions for Improvements.*

By J. SHEPHERD.

Until about 1903 practically all large generating units were of the low-speed marine type engine, with low-speed generators directly mounted upon the shafts. These engines were of sound workmanship and design. The economic life of such plant, however, was shortened by the rapid progress of steam turbo-generators, and nearly all such engine generators have now been discarded and scrapped.

The relative steam consumptions averaged 18 lb. of steam per kilowatt-hour for compound engines; about 4,000 kw. (1904). In 1909, 1912 and 1918 (when 20,000 kw. was attained) the respective values for impulse turbines were 15, 13 and 11 lb. per kilowatt-hour. Whilst the steam economy of turbo-generators compared with engine generators is most marked, the same favourable comparison does not hold for reliability and physical life. The necessary time has not been available in which to gain experience and evolve established designs; each development opens up new difficulties for solution, of which the operating engineer has experience.

As a rule, serious failures with turbo-generators only develop when machines are of large size and form units in a system of some magnitude. If, as generally happens, the machine is set on fire, it may be hours before it is cool enough for examination. By that time the charred remains are in such a condition that evidence of the cause of breakdown usually has been entirely destroyed.

After several years of experience the more usual types of failures may be roughly classified under (1) mechanical weakness, (2) electrical weakness, (3) heating and fire risk, (4) ventilation difficulties

MECHANICAL WEAKNESSES.

The efficiency of the steam turbine increases materially with its speed. The centrifugal stresses in the rotor teeth, upon the rotor coils and their insulation are serious, particularly so with speeds of 3,000 revs. per min., increasing with the square of the speed. To limit these stresses and retain the maximum speed of rotation, the diameter of the rotor is reduced to the smallest practical dimension, the length being increased. The running speed of the generator is generally above its first "critical" speed, and when the plant is started and stopped, the rotor must pass through this speed with its attendant risks.

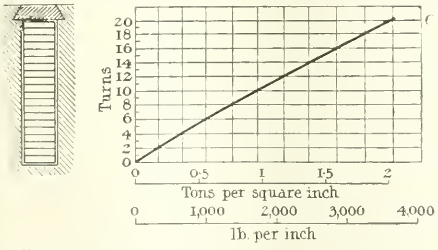

FIG. 1.—CENTRIFUGAL STRESSES IN ROTOR WINDINGS.

The portion of the coils within the winding slots is retained in place by metal wedges driven into dove-tailed recesses, machined out of the top of the rotor teeth. The portion of the windings forming at loops at each end of the rotor cannot be so held. Originally they were secured in place by steel wire bands wound tightly upon the completed coils, but there is then a tendency for the coils to set in radially, slackening the steel bands and throwing the rotor out of mechanical balance. Hence solid rings of high tensile steel are now used instead, although hidden flaws may exist. Moreover, alloys like nickel and chrome steel are comparatively new, and the effect on them of prolonged heat and continued stress has yet to be determined.

As an extreme example, Fig. 1 illustrates the radial stresses in pounds per inch of coil length from turn to turn of such a rotor coil, the rotor being 36 in. in diameter and 3,000 revs. per min. The stress increases in a parabolic curve from the bottom of the slot. The same curve to a different scale represents the crushing force per square inch on the insulation between the turns. Assuming that the turns are absolutely flat upon each other, giving uniform pressure throughout their area, the pressures per square inch on the example taken are:—

Between the complete coil and wedge	4,600 lb. per square inch.
Between the last two turns...............	4,340 lb. ,, ,,
Between the first two turns	200 lb. ,, ,,

The choice of insulation capable of withstanding such pressures is very limited. For many years a flexible type of coupling between the rotors of the alternators and turbine was generally used, but some 12 years ago Continental makers began to discard such couplings, and that practice has now been followed here.

The internal losses of a modern generator are about 4 to 5 per cent. of the rated output. The heat resulting from these losses is dissipated by forced air ventilation through specially constructed air vents in the rotor and stator. With high speeds, smaller diameters, and increased length of rotors, it becomes difficult to pass the required amount of cooling air through the rotors. On modern machines the volume of the stator taken up by ventilating spaces is from 15 to 25 per cent. of the total volume.

The method of open construction gives a mechanically weak form of stator core and, under the alternating stress, chattering of the teeth may occur. The result of the vibration on the insulation of the stator bars is obviously undesirable. Another mechanical defect in the stator is the method of attaching the stampings to the frame. With faulty workmanship and inadequate proportion of the keys, the core works slack at the keyways. If the volume of iron is insufficient, induction in the iron near the keys may cause serious overheating. Inaccurate punching of the plates is another source of trouble. The construction having dove-tailed keyways punched out of the stampings gives a sounder machine.

Owing to the limitation of railway facilities the stators of large generators must be built on site under usually somewhat primitive conditions. Consequently, the preparation of the stampings and their building may not be so carefully carried out as when erection takes place in the shops.

ELECTRICAL WEAKNESSES.

Electrical weaknesses in turbo-alternators have mainly developed since the size of the machines and the systems to which they were connected increased to over 30,000 kw. on a single set of bus-bars. A thickness of 0·15 in. of insulation is usually sufficient for ordinary working pressures. Micanite insulation is admirable so long as it is not over-stressed during short circuits. If, however, the stator bars are not adequately supported, bending and cracking will occur. As a rule, such a crack cannot be detected, and its existence is unknown until a breakdown occurs. To overcome this defect different types of insulation have been introduced using Empire tape and similar fabric, interleaved with mica. This, when new, is fairly flexible and will yield a limited extent without cracking, but after use at the ordinary working temperature of turbo-alternators it becomes as brittle as mica.

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* Abstract of a Paper presented before the Institution of Electrical Engineers.

From the constructional point of view the one bar per slot of stator winding has advantages. Continental makers construct the bar of various laminae, twisted within the slot. The joint between the bars and the end connectors is difficult to make; generally it is soldered. During construction a defective joint may be detected by a fall of P.D., or by circulating a current much in excess of the maximum full-load current through the windings and feeling for hot joints. One undetected joint on a working machine is a matter that may have serious consequences. As its position is not known, it cannot be kept under observation. A faulty joint is only detected through the machine giving way and the solder melting, with every risk of a fire.

The greatest electrical weakness in turbo-generators constructed a few years ago was their inability to withstand the stresses set up on short-circuit. If even moderate movement of the stator bars occurs, cracking of the insulation is probable. If a solid conductor could be used, a very rigid bar construction is possible, and the risk of the conductor bending under short-circuit would be small.

On the multiple bar and crushed strand construction, difficulties occur with stator bars of considerable section. The conductors do not nest firmly together, and a tight mica wrap around them cannot be made. The latest method of constructing stator bars is a more complete development of lamination. This construction eliminates eddy currents, gives uniform distribution of current in the stator bar and facilitates small joints, which enable the tapes to be fusion welded together.

The popular remedy against short-circuit stresses is the provision of high reactance within or without the machines, reducing the current on short-circuit to from 8 to 10 times full-load current. This reactance, however, results in poor regulation. Each generator must be controlled by an automatic regulator giving satisfactory pressure on ordinary loads.

In large generators the ordinary method of leading away the current of the stator is open to improvement. In all large systems it is best to lead away each phase by a separate lead-covered cable.

Heating and Fire Risk.

With the old type of low-speed generator the fire risk was not great, as the proportion of inflammable material was small. With a modern turbo-alternator the conditions are different. Owing to the high speed and compact design with small volume of active material, much inflammable insulation is built into the machine. With forced air ventilation the generator is totally enclosed. When working, no part of the winding is open to inspection. Fires may originate through defective joints, short-circuits, failure of insulation, &c. An arc, however started, has immediately a considerable amount of energy fed into it. Parts are so designed as to allow the cooling air to circulate rapidly, and it is constantly renewed by the fans. The inflammable character of the winding may be augmented by oily vapour and dirt carried into the machine by the ventilating air and deposited as sticky material on the conductors.

A fire once started at or near the end connectors is immediately swept round the openly spaced windings, and their destruction is a matter of only a few seconds. The momentum of the rotors causes continual rotation for 30 minutes or more after the steam has been shut off. Air dampers provided in the external ventilating air ducts and other devices involving the use of nitrogen, CO_2, &c., within the machine, are of doubtful utility.

Ventilation Troubles.

The amount of air required to carry away the internal heat is dependent upon the internal losses and upon the permissible temperature rise. Allowing a rise of 50°F. in the cooling air, and a loss of 4 per cent. in the generator, about 4 cubic ft. of air per minute per kilowatt of output is sufficient. Moreover, dust suspended in the air will choke up the internal ventilating spaces in time, and filtration of the air becomes necessary. It is desirable on the hottest days of summer to cool the incoming air. In dry filters the filtering cloth is of considerable area, its renewal is troublesome.

Air washers of the spray type have been much used, but have not justified the high opinion in which they were formerly held. More or less free moisture has been introduced into the machines by their use.

The air is generally drawn into the bottom of the machine by fans attached to the ends of the rotor. In large high-speed machines the fans may be external to the machine and separately motor driven. The correct distribution of the air after entering the machine is a matter of difficulty.

Practically all machines are rated on ultimate temperatures, *i.e.*, the temperature of the hottest part of the machine on the outside of the insulation; but the position of this hot part is inaccessible when working, and the temperature may or may not be revealed by thermo-couples or resistance thermometers. The temperature of the ventilation air leaving the machine indicates roughly the amount of heating of the machine, but gives neither the maximum nor the average temperature, as the temperature gradient is unknown.

Suggested Lines of Improvement.

So far, the Paper has given a statement of the ordinary difficulties experienced with turbo-generators. The engineer is at a serious disadvantage when using such machines, which must often be worked at maximum capacity.

Such generating plant is entirely enclosed, and can neither be inspected nor its temperature easily determined under working conditions. Faults which are suspected are difficult to locate.

From the operating point of view, the requirements of modern turbo-generators are (1) reliability, (2) efficiency, (3) ease of operation. (1) Requires better means of knowing what is happening inside the enclosed frame of the machine. It ought to be possible to determine continuously, with some accuracy and by simple means, the temperature of any part of the machine, and to anticipate breakdowns by the indication of rising temperature of the faulty part before the fault develops. The output of the machine should be independent of air temperatures. There should be some reserve of capacity to meet sudden overloads.

The first requisite is to manufacture a suitable insulation. A pressure of over 2 tons per square inch may occur with the insulation between and around the outer turns, and the insulation must stand continuously a temperature of 200 F. The choice of suitable insulation at present is restricted to mica and hard paper. The coil should be made of as great a width as possible, and the separate turns laid flat upon each other. Distortion at the end of the loops can be prevented by substantial metal packing between them. The safest band over the coils would be one of drawn steel tape, which can adjust itself to the strains upon it. Reduction in rotor diameter is a method of reducing the centrifugal stresses.

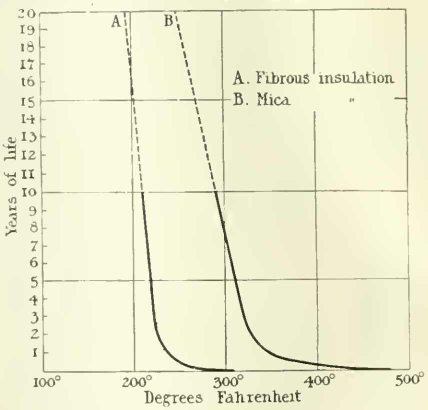

Fig. 2.—Curve of Temperature and Life of Insulation.

The problem of inadequate size of keys is a matter of more ample proportions, or of reversion to the original design of keys stamped out of the discs. No trouble usually occurs through lack of stiffness in the portion of coils within the winding slot, except at the very extremities of the slot where displacement of the end connections may occur. The remedy would appear to be less drastic division of conductors, or a better nesting together and impregnation before wrapping.

The end connections, if attached to weak laminated stator bars, are difficult to stay adequately. Continuous coil supports having winding slots should be provided for the entire length of the end connectors.

So far as is known, the only two insulating materials which can withstand temperatures of 250° to 300°F. for any prolonged period without charring are mica and asbestos. As a rule, mica cannot be employed without a fibrous or paper backing on to which it is built by varnish or gums, whilst asbestos requires similar material to fill up the pores and render it suitable for insulation use. Such varnish or gums soften at temperatures approaching 300°F. The melting point of solder, for ordinary mixtures, is about 370°F. to 390°F.

There remains the question of thermal expansion at these high temperatures. A steel rotor 80 in. long on the polar face, with a temperature rise from 60°F. to 250°F, will receive an increment of 0·0912 in., whilst the copper coil within the rotor slot will have an increment of 0·1452 in.; that is, the copper increases beyond the steel by 0·0540 in. in the rotor length of 80 in. This increase, though very small, takes place whilst the coils are subjected to severe lateral pressure, and the effect of movement under such conditions will certainly shorten the life of the insulation.

The relation of the temperature to the useful life of the insulation is of great importance. Two curves are given, showing the relation of the useful life of insulation to the temperature, for:—

(A) Fibrous insulation, including fabric and paper; (B) mica and micanite insulation. The results have been reduced to Fahrenheit scale, and each curve has been continued to a hypothetical life of 20 years (*see* Fig. 2). A reduced temperature gives a greatly increased life. For large machines working continuously night and day for months together, a temperature of 150°F. has much to recommend it from the point of view of capacity to meet sudden overloads and long life of insulation. Inflammable packing insertion and all fibrous insulation should be avoided in both stator and rotor. The ideal insulation would have a substantial body of mica built up without inflammable gum or varnish and with some degree of flexibility. The binding material of the mica and packing must have a high thermal conductivity and suitable specific inductive capacity.

(*To be concluded.*)

The Annual Physical Society and Optical Society Exhibition.

The holding of the Physical Society's Exhibition last week after an interval of six years was a welcome event. For it was in 1913 that the last was held, and during this period our manufacturers have been far too busy to think of such peaceful displays.

The occasion was marked by some modifications. December, this session, had proved to be inconvenient and so a later date than usual was chosen, the time when the Imperial College is available for such a purpose being, of course, dependent upon the vacation. Moreover, it was decided this year to hold the Exhibition for two days instead of one; and there is no doubt that this change was popular. Also, on the present occasion, the Optical Society co-operated with the Physical Society, so that the Optical Exhibits were more numerous.

We think it will be agreed that the Exhibition was eminently successful. The number of firms exhibiting was larger than usual, and although the advance was not so marked as might have been expected after six years, there was sufficient of interest to occupy many a physicist or engineer for the whole of the two available days.

In the way of attractions which might be regarded as side-shows, two short lectures were provided. One of these was by Prof. F. J. CHESHIRE on "Polarisation of Light." Experiments were shown illustrating the well-known properties of polarised light, which lend themselves exceedingly well to demonstrations of this kind. The other lecture was by Prof. A. O. RANKINE on the use of light in the transmission and reproduction of sound. The transmitting device, which was developed by Prof. Rankine during the war, was explained, and visitors had the advantage of testing the transmission for themselves. The lectures were given on both days in the afternoon and evening, alternately for each lecture, and they were very well attended.

Another side-show was the demonstration of the "Sheringham Daylight" by Mr. L. C. MARTIN. This was shown recently before the Illuminating Engineering Society * and attracted a good deal of attention. On the present occasion, visitors had the opportunity of seeing at their leisure, the great differences in the ordinary artificial light and in that produced by reflection from a suitably variegated screen. The difference is certainly remarkable.

Turning to the exhibits, it may be mentioned that there was an interesting display of captured German instruments, shown by the Admiralty and Air Ministry. These were mainly of an optical character and were certainly instructive. In the main, they gave the impression of rough workmanship compared with our own instruments. Possibly this was due to some extent to lack of material, but even so, the workmanship did not seem to be at all of a high class in many cases. Undoubtedly we have the satisfaction of knowing that although we started very handicapped at the outbreak of war, we succeeded not only in catching up the German productions but in very distinctly surpassing them.

H. TINSLEY & COMPANY.

A number of interesting exhibits were shown by Messrs. Tinsley.

Thermo-electric Potentiometer.—This potentiometer (the manufacture of which was undertaken specially for the National Physical Laboratory) is based upon that described by H. Dieselhorst in "Zeitschrift für Instrumenten Kunde," 1908, and, we understand, is the first of its kind made in England. The potentiometer consists essentially of a divided circuit, the potential being obtained from two points in each arm of the circuit. Fig. 1 shows the theoretical diagram.

The potentiometer current is kept at a standard value in the usual manner by equating the drop across a resistance to a standard cell. The current entering at the point *A* divides the resistance of the two branches, being so arranged that the current in the right-hand arm is one-tenth that in the left. This proportion is always maintained for any position of the switches by means of the compensating coils which are put in circuit as others are cut out.

The top and bottom sets of coils are interconnected so that the top contact moves to the right while the bottom moves to the left. Similarly the same total resistance is maintained when either the right or left hand decades are moved, as will be seen from Fig. 1. Any thermo E.M.F. which may occur due to the motion of the switch is rendered negligible by this arrangement of divided circuit. If an E.M.F. occurs upon the moving of the switch on the first dial, the thermo E.M.F. will become added to the battery E.M.F. of about 2 volts, and is therefore negligible. If the thermo E.M.F. occurs on moving the switch of the second or third dial, it will act in a divided circuit, one side of which will be added to, while the other is substracted from, the main E.M.F., the resultant alteration being negligible and never exceeding 1·3 per cent. of the value of the thermo E.M.F., which would not itself exceed 10^{-6} volts. Moving the switches when the instrument is set up causes no deflection of the galvanometer as usually occurs.

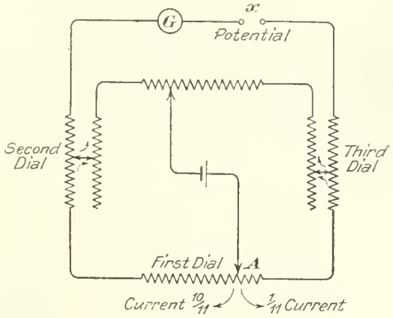

FIG. 1.

Double Kelvin Bridge with Standard.—This bridge has been specially constructed to provide a self-contained instrument for low resistance measurements. Four standard resistances are contained in the instrument, namely, 1 ohm, 0·1 ohm, 0·01 ohm and 0·001 ohm. By use of the ratios this allows measurements to be made to five figures of all values of resistance from 1,000 ohms to 0·001 ohm. Terminals are provided for measuring against independent standards if required.

Shunts.—The standardisation of low resistance shunts has been made a speciality of by Messrs. Tinsley. Two sizes of the Drysdale-Tinsley non-inductive type were shown, together with their temperature-resistance curves. We understand that great difficulty has been experienced by Messrs. Tinsley in getting suitable resistance material for the purpose of standard resistance work, and many of the manufacturers' guarantees in this respect are hopelessly wide of their results. Co-efficients of as much as 260 parts in a million per degree centigrade have been found in samples guaranteed as less than 30. Fig. 2 shows some typical samples of material used for the construction of these shunts. The poor quality of the English as compared with the foreign material will be noticed, and therefore our British manufacturers of wire must not feel surprised if their material is not employed.

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* *See* THE ELECTRICIAN, Vol. LXXXIII, p. 633.

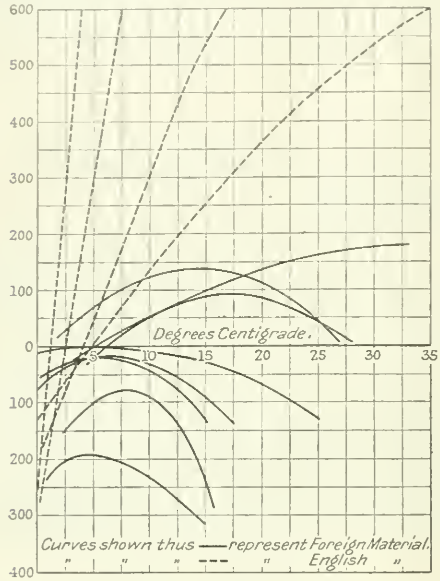


Fig. 2.

Vernier Potentiometer.—A new pattern potentiometer has been developed to give the same range as this firm's "Universal Potentiometer," but without using a slide wire. This instrument is provided with three dials, the first reading (when using 2-volt accumulators) 0·1 volt per stud, the second 0·001 volt per stud, and the third 0·00001 volt per stud. The second dial is the "vernier" dial, it being shunted across any two studs of the first dial according to the position of that index. All the studs are capped with silver-gold alloy and the contact arms are tipped with the same material. A special form of fine adjustment rheostat is provided (for balancing the standard cell in setting the potentiometer) in the accumulator circuit, which gives an adjustment of 2 ohms, on what is equivalent to a 6-metre wire. A ratio plug is provided for reducing all readings by 10, thus allowing the potentiometer to be used to read up to 18 volts or down to 10^{-6} volts.

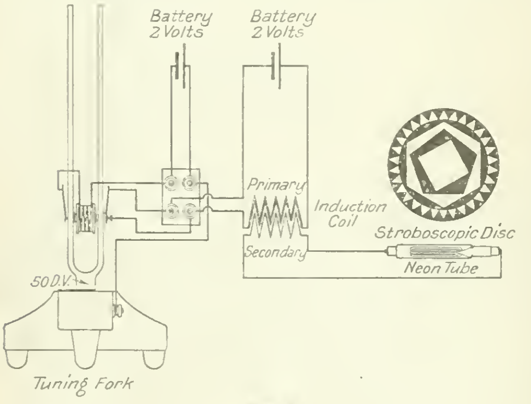


Fig. 3.

Variable Self and Mutual Inductor.—This is a new type of instrument, two of the chief features being the convenience with which it can be operated and the scale read. The scale is arranged on the top face of the instrument in clear black lines on white background, and the handle for operating is at the right-hand side at a convenient height.

Considerable trouble has been experienced with previous designs, due to the materials used in their construction changing dimensions and causing sticking. This new type has been specially constructed with a view to the elimination of those defects, by the provision of a very robust frame and liberal clearance between moving and fixed coils. The scale law is practically uniform throughout its entire length, of about 18 in., showing a barely perceptible opening out in the centre.

The range of the instrument shown is from 6 to 159 millihenries self inductance and 0 to 34 millihenry mutual inductance, but any desired range can be constructed.

Gall and Tinsley's Artificial Track Circuit.—This is described in another column (*see* p. 54).

Stroboscopic Apparatus for Speed Measurement.—This method of speed measurement has been developed (from Dr. C. V. Drysdale's scheme) by Dr. Aston and others at the Royal Aircraft Factory. The card is now used as shown by Fig. 3 in conjunction with a neon tube, the discharge through which is controlled by a tuning fork. A card is supplied from which the speed of a motor on whose shaft the card is attached can be judged, and any one of a number of speeds can be maintained if the observed figure on the card is kept from changing. The number of speeds available vary from 50 up to 1333·3, with intervals of something like 50, with the card as shown.

The Cambridge & Paul Instrument Company, Ltd.

The amalgamation of the Cambridge Scientific Instrument Company with R. W. Paul naturally resulted in an interesting display which repaid careful inspection.

Electrical CO$_2$ Recorder.—This instrument is on novel lines and merits the attention of station engineers, for it enables the percentage of CO$_2$ in flue gases to be determined by an electrical method, which does not involve the use of any chemical absorbent. The instrument is stated to be accurate and sensitive, and it possesses the advantage that while the portion of the instrument through which the gases actually pass can be placed in close proximity to the flue, the recorder may be some considerable distance away. If desired an indicator may be used instead of the recorder.

The method employed for measuring the percentage of CO$_2$ is one devised by Dr. G. A. Shakespear, of the University of Birmingham, for testing the purity of gases. The composition of the flue-gas is compared with that of air by means of an instrument known as a katharometer, which consists of two identical spirals of platinum wire contained in two cells drilled in a copper block, each of the spirals being connected to form one arm of a Wheatstone Bridge circuit. If a fairly large current is allowed to flow in this circuit the two spirals will become heated and will lose heat to the walls

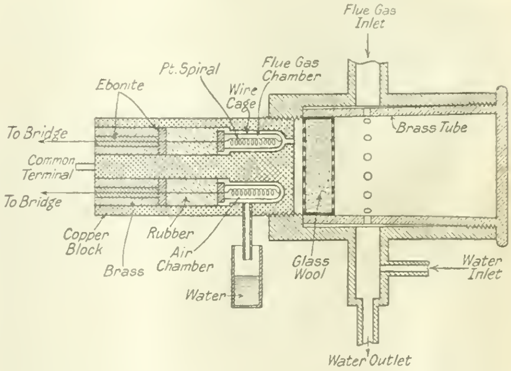


Fig. 4.

of the cells. The rate of cooling will depend on the thermal conductivities of the gases in the cells, so that if the two cells contain gases of different conductivities the two spirals will cool at different rates, and one will therefore be maintained at a lower temperature than the other. The difference in temperature of the two wires will cause a deflection of the galvanometer, the extent of the deflection depending on the difference in conductivity of the two gases. If, therefore, one cell of the katharometer contains a pure gas and the other the same gas mixed with some other constituent, the extent of the deflection will be an indication of the amount of the second gas present, and the galvanometer can be calibrated to show directly the percentage composition of the mixture. The difference in conductivity between air and carbon-dioxide enables the method to be employed to determine the percentage of CO_2 in flue gases. The arrangement is shown diagrammatically in Fig. 4.

The photograph (Fig. 5) shows the katharometer and water aspirator, which are enclosed in a metal case with glass door. *H* is the katharometer which is screwed into the chamber *K*. The open cell of the katharometer communicates with this chamber, through which the flue gases are drawn by the water aspirator *E*. The other cell of the katharometer, which is filled with air, is connected to the tube *F* which contains water, so that the air in the katharometer cell is kept saturated. The object of this is to prevent the water vapour in the flue gases from vitiating the readings, as it would do if the flue gases were compared with dry air. When the gas in both cells is saturated with water vapour the effect of the water vapour is the same on both sides and the readings are not influenced. Owing to the nearly equal conductivities of air and carbon-monoxide the presence of the latter gas does not affect the readings. *G* (Fig. 5) is a screwed plug to which is attached a filter box of glass wool for cleaning the gas which passes into the katharometer. *D* is the water inlet to the aspirator, and the pipe carrying the gas from the flue is connected to the tube *C*. A soot filter should be inserted between the flue and the tube *C*, and at the lowest point of the pipe a T-piece with its end dipping under water should be provided as a drain for condensed steam. The U-tube on the front of the aspirator is half-filled with water, and when the aspirator is not working the water level in this tube will be quite steady and will indicate the chimney draught. The position of the water in the U-tube also indicates the presence of any obstruction in the gas supply pipe, as this causes the water to be unusually high on the aspirator side. *B* (Fig. 5) is a water-flow regulator designed to give maximum efficiency in the working of the aspirator. The flow is adjusted until water runs freely out of the fine tube at the bottom, and only trickles out of the wider tube, which is an overflow pipe. The water consumption is about 5 gallons per hour.

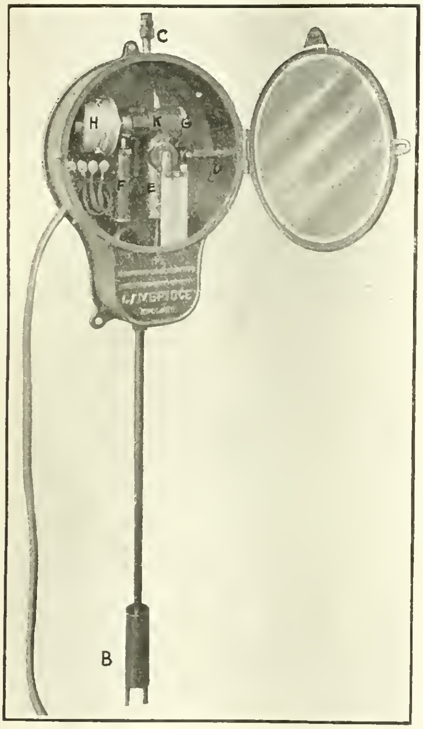


Fig. 5.

The records (of which Fig. 6 is a sample) are obtained by means of a recording galvanometer of the type commonly known as the Thread Recorder. This consists essentially of a suspended coil galvanometer in which the pointer is depressed by means of a clockwork mechanism every minute or half-minute on to a thread impregnated with ink, which passes above the surface of a revolving drum carrying a chart. The thread is pressed by the pointer against the chart, and a mark is made which records the position of the pointer at the moment. Between the times of marking the pointer is allowed to swing freely and take up its new position, so that the succession of dots forms a record of the varying positions of the pointer. The charts are calibrated to read directly the percentage of CO_2. It will be noticed that the record differs very materially from the usual type of CO_2 record. We were informed that there is no appreciable lag, which is of importance; the existence of lag one would naturally expect, and it would be a distinct defect if pronounced.

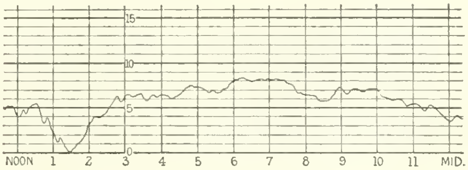


Fig. 6.

The katharometer terminals are connected to the recorder by 4-way lead covered leads, which may be of any length required. A 2-volt 40-ampere-hour battery is used to operate the instrument. Provision is made for testing at intervals the current flowing through the katharometer coils, and rheostats are provided to enable this current to be kept constant in spite of variations in the voltage of the battery.

Review.

Automobile Batteries. By Harold H. U. Cross. (London: E. & F. N. Spon.) Pp. viii.+101. 4s. net.

Considering its ambitious sub-title, this is a book which falls somewhat short of the author's evidently good intentions. Both in treatment and the extent to which the fields indicated are covered, the general impression is one of insufficient sense of proportion having been exercised in laying out the sections of the volume. Fifteen pages are allotted to dry cells out of a total of rather over 90 pages, followed by 67 pages dealing with small lead cells, mainly from the standpoint of charging and plate repairs, with notes on suitable plant and accessory apparatus. Then follows the shortest section (12 pages) on the alkaline type of secondary cell of which the Edison is typical. No mention is made of some of the apparatus which is principally used to charge accumulators, including the mercury arc rectifier and the rotary converter, whilst the Nodon valve is alluded to as the "Nocton" valve (the index has same spelling!), and is described as "very popular." This popularity certainly does not apply in Great Britain. Mr. Cross's somewhat loose terminology is exemplified by such phrases as "this film which is formed . . . and thus sorts out the alternating current as it comes by." Electric vehicle batteries are barely mentioned, even the well-known "Iron-clad Exide" finding no place. Very little numerical data is included, although chemical equations in some detail for a work of this character are quoted, which is an instance of the inadequate proportion alluded to above. In spite of these shortcomings, amateurs will undoubtedly derive much practical instruction and help from this little work. It is hoped, however, that, should future editions be called for, the treatment will be more thorough, and omissions referred to made good.

RAYMOND J. MITCHELL.

Correspondence.

THE TESTING OF TRANSFORMER OILS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the course of a number of investigations into cases of transformer breakdown, we have come to the conclusion that many engineers find difficulty in deciding when to change the oil in their plant. We therefore put forward a few suggestions for testing the condition of transformer oil in the hope that they may be of interest.

The oil should be sampled at regular intervals, say, once in three months, preferably from a cock near the bottom of the tank. The first pint or so drawn should be returned, and then a small quantity should be mixed with twice its volume of natural petroleum spirit (not cracked spirit, shale spirit, or benzole) in a clean, well-stoppered bottle, and allowed to stand 12 hours in a cool place.

This treatment will cause any sludge which may be forming in the oil to fall to the bottom as a deposit, and if the bottles be kept, the amount of deposit from any test may be compared with that from preceding tests.

When an oil oxidises sludge begins to form long before it begins to deposit—a quantity being held in solution, and it should, we take it, be the aim of the engineer to change his oil just before it reaches saturation point. Since warm oil holds very much more sludge than cold, it follows that a good deal can be learnt by simply cooling samples overnight and noting the amount of turbidity.

A close watch should also be kept upon the di-electric strength or what in the case of high class oils amounts to the same thing, upon the dryness of the oil. It is not sufficiently appreciated that during oxidation of petroleum water is formed as well as sludge. This fact would have forced itself upon the attention of engineers long since were it not that the warmth of the transformer generally causes the moisture to evaporate. Whether the moisture escapes as quickly as it is formed depends however upon the design of the transformer case.

A rough test is to heat the oil in a test-tube, when a crackling and frothing indicates moisture, but this is only sensitive enough to indicate a really dangerous proportion. A much better method is to determine the di-electric strength by raising the voltage to breakdown point between a pair of electrodes immersed in oil at a known distance apart. When traces of water are present small sparks traverse the gap at a voltage considerably below that of complete breakdown.

We do not attempt to propose rigid rules for managing the oil insulation of a transformer, but we think that by studying the behaviour of his oil in the manner indicated above, an engineer may acquire experience which will help him in guarding against breakdown.—We are, &c.,

London, E.14, Jan. 7. ALEXANDER DUCKHAM & CO., LTD.

THE THERMIONIC VALVE AND ITS DEVELOPMENT IN RADIO TELEGRAPHY AND TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The complaint made by M. Marius Latour in your issue of January 9, that Dr. Fleming has given no credit to French engineers in general and Latour in particular for their work in connection with the development of the applications of the thermionic valve, is one which will arouse interest. It is rather a departure and somewhat of a precedent for an engineer to complain in the technical press that his work has not received recognition in a certain book dealing with the subject. M. Latour, however, has some reason for his feelings in the matter. As a wireless engineer he has few equals in any country, and he is responsible for nearly all the work carried out by the French in the design of valve amplifiers. This fact, however, is only now being disclosed through the publication of his very numerous patents, and Dr. Fleming at the time of writing his book was not in full possession of the facts.

I am chiefly interested in Latour's letter since I desire to avoid any similar complaints being made against myself. I have completed for the Wireless Press, Ltd., a very comprehensive volume dealing with the use of vacuum tubes, and am now making a final endeavour to apportion credit where it is due, and to include, besides the results of my own experience, the substance of papers, articles, &c., by other investigators. I would, therefore, be glad if you would permit me to make a general request for copies of papers, data, &c., in order that my volume will be truly representative of modern developments in all countries. Such a request, though unusual, will result in a final check on my own searches in technical literature, and will preclude the possibility of "surprise" in any quarter where recognition was expected. M. Marius Latour, I may add, has already given me very generous assistance in supplying me with data regarding his work. I am, &c., JOHN SCOTT TAGGART.

Ponders End, Middlesex, Jan. 10.

STANDARDS OF HIGH FREQUENCY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an interesting paper published recently in the Proceedings of the Royal Society (A, Vol. 95, 1919) Mr. Ashutosh Dey describes a new method for the absolute determination of frequency. He shows that a pendulum of natural frequency about two revolutions per second can be maintained in permanent oscillation by means of an alternating (or interrupted) current of very much higher frequency, when the higher frequency is an exact multiple of that of the pendulum. For example, the ratio of frequencies may even be as high as 140. Lord Rayleigh (Theory of Sound, 2nd edition, Vol. 1, p. 83) had already shown that a pendulum could be maintained by a current of frequency double its own. I would suggest that Mr. Dey's interesting extension to the higher multiples may be of importance in the standardisation of radio frequencies. It may be possible to maintain a tuning fork of natural frequency (say) 5,000 revs. per second by means of an alternating current of 50,000 or even 500,000 r. per second, and thus form a useful check on the other methods of standardising wavemeters. If we follow Lord Rayleigh's system as used by Mr. Dey, the (magnet) coils which carry the high frequency current, and act on the prongs of the fork, should be placed facing the ends of the prongs so that the magnetic forces they exert on the prongs shall pull longitudinally on them and not tend to deflect them from their positions of rest. If this experiment is successful we shall have to think how to go higher, by arranging to excite a *circuit* by a current whose frequency is a multiple of the natural frequency of the circuit.—I am, &c.,

Londonderry, Jan. 5. ALBERT CAMPBELL.

THE TEN SHILLING COAL REBATE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been asked by the Coal Controller to send round to electric supply companies a copy of the printed "Prescription" issued by the Board of Trade with reference to obtaining and passing on to the consumer the rebate of 10s. per ton on coal used for generating electricity sold for domestic or household purposes, together with an explanatory memorandum approved by the Coal Controller. I posted these last week (over 200 in all).

In case, however, any particular undertaking finds they have not received the same, will they kindly drop me a line, and I will post copies to them by return.—I am, &c.,

London, Jan. 9. T. W. COLE, *Secretary*,
The Provincial Electric Supply
Committee of the United Kingdom.

The Electrician.

FRIDAY, JANUARY 16th, 1920.
Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

Development of Heavy Electrical Machinery.

Man, being vain, as a rule takes greater pride in recording his successes than his failures. An exception is that of a well-known public man who attributed his success to the fact that he failed for the Indian Civil Service.

Bearing in mind that practically the whole of progress is founded on the mistakes of the past, is it not remarkable that those who make the mistakes are averse to describing them? Generally speaking, the work is left for others, and the tale loses nothing in the telling. Take the case of the Papers read before any of the engineering Institutions. It is common knowledge that these record the triumphs of engineering. Not only do the papers themselves deal with triumphs, but those who take part in the discussions also harp on the same string, and it is often amusing to note the self-importance of men whose fame will assuredly either die before them or with them. Many of those who have done well in their profession are apt to overlook their indebtedness to that profession.

We state emphatically that pride of place should be given to the recording of failures. The bridge across the St. Lawrence teaches engineers a lesson better by far than that taught by the Forth Bridge. He is a poor sort of engineer who fails to draw useful conclusions from the lesson, and who tries to make capital out of a brother engineer's mistakes. On the failure of a structure alert brains are brought into play, and engineers, provided sufficient data are disclosed, take it upon themselves to determine the reasons for the failure. Beneath contempt is the man who, lacking in constructive ability, contents himself with destructive criticism.

Lessons from the Failure of Turbo-Generators.

The thoughts set down in the foregoing paragraphs came to us as we perused a Paper entitled "Failures of Turbo-Generators and Suggestions for Improvements," that was read recently before the Institution of Electrical Engineers by Mr. J. Shepherd. The author, we imagine, is well qualified to write a Paper on turbine failures; but, instead of dealing with failures in the concrete, he deals with them in the abstract, and, in consequence, much of the Paper is less interesting than it need be. In fact, we are surprised to find a good deal of matter that must be familiar to every student of the subject. In our opinion, the author has given three Papers in one. These are briefly: (*a*) Failures; (*b*) Improvements; and (*c*) Methods of Cooling.

Some years ago we published a Paper dealing with breakdowns in the *concrete*, and it has seldom been our privilege to read a more instructive article. Certain of the breakdowns described were due to constructions which Mr. Shepherd states are the practice of to-day. Thus, we are told that the joints between the bars and end connectors of the stator are soldered, and a faulty joint is only detected through the machine giving way and the solder melting, with every risk of fire. In the author's ideal machine no repairs would be necessary and all the joints would be fusion welded. Expressed in the plainest possible speech, solder is the curse of engineering, and its misuse is due to the ease with which it can be misapplied. It is nothing more than a certain skill in the use of the soldering iron that enables a gas fitter to describe himself on a signboard as an electrical engineer. When real engineers learn what kind of stress can be safely applied to a soldered joint, such joints will automatically disappear from electrical engineering (as did sealing-wax and such like varnishes as insulating materials more than a quarter of a century ago), the more so since the melting of any one of a hundred or more joints may set a machine on fire. *What engineering!*

Solid v. Built-up Rotors.

We do not see eye to eye with Mr. Shepherd on several points of fundamental importance. Thus, we are told that the cylindrical pattern of rotor with radial slots has now become universal, and "generally the rotor and its shaft are turned out of a single forging." Readers of this journal need not be reminded of an article in these columns, about two years ago, which gave rise to an informative discussion on solid and built-up rotors. If solid rotors are now generally used there must have been a radical alteration during the past two years of which we have no knowledge. For machines of the largest outputs there is little experience to guide one in the choice of type, but what experience there is tends to show a preference by designers for the built-up rotor. Presumably, the merits of both types have been considered before making a choice. Perhaps the solid rotor machines spoken of are of small or medium output.

Again, although the use of (tinned) steel wire (presumably soldered) is rightly condemned for the holding in place of the rotor end-windings, Mr. Shepherd advocates the use of a band of drawn steel tape, and of this form of banding he states that it is the one used for the much more severe conditions required by the re-inforcement of high-velocity gun tubes. The determination of severity of conditions is a problem for the student of the strength of materials; but, irrespective of the severity of the conditions in the two cases, the conditions are certainly not alike. In our opinion, and without knowing the method of securing the bands, we imagine that engineers will continue to favour the solid or composite end bell.

The Important Question of Cooling.

The section of Mr. Shepherd's Paper dealing with the cooling of turbo-alternators is excellent, and is probably the most complete account that has been published. In itself it would have formed a Paper sufficient to give rise to a helpful discussion. Engineers and designers would do well to remember that specific outputs have got to be increased, and with the materials available specific output can only be increased by improved methods of cooling. As was to be expected, the proposal to substitute water cooling for air cooling was subjected to adverse criticism. Irrespective of the criticism the air cooling of turbo-alternators will have to go as surely as the air cooling of transformers had to go, and the sooner this is recognised the better. Water cooling must be regarded merely as the beginning of a new era in the design of turbo-generators.

In conclusion, we suggest that an electrical manufacturer having a small (soldered joint) machine on his scrap heap should arrange to study its performance when immersed in oil. We venture to predict that, by exercising a little ingenuity and common sense in the arrangement of the oil bath, the results would surprise him. At its worst the result would be no worse than many of the failures in turbo-alternator designs in the past.

Electricity Supply Bills.

We give below an abstract of the provisions of the principal Electric Supply Bills of the 1920 Parliamentary Session.

In a Bill promoted by Urban District Councils of Nanty-Glo and Blaina (Mon.) and Brynmawr (Brecon) power is sought to constitute a joint board for erecting a generating station in Nanty-Glo and supplying electricity in the areas of both Urban Councils. The estimated cost of equipping the station and laying cables, &c., is £33,000. It is proposed to incorporate the Land Clauses Acts(except sec. 127 of the Consolidation Act of 1845), and the provisions in the schedule to the Electric Lighting (Clauses) Act of 1899 (except secs. 2 to 7, 23, 60, 63 to 68, 75, 78, 83 and 84); and the proposed board shall consist of 12 members, eight members of Nanty-Glo Council and four of Brynmawr Council. Provision is made for the appointment of members of the board, the appointment of committees, officials, &c. The board may charge 13s. 4d. for any amount of electrical energy up to 20 units per quarter, and 8d. a unit thereafter. Power is given to take a supply of electrical energy in bulk to sell, let for hire and fix lamps, meters, electric lines, switches and other electrical fittings; to make by-laws as to wires, apparatus and fittings, to discontinue supply in certain cases and to refuse supply where payment is in arrear. Power is also sought to attach brackets to buildings, to employ overhead lines, to allow discounts, to open showrooms, &c. It is sought to borrow £20,000 for the purchase of lands and the erection of a generating station (to be repaid within 60 years) and £12,000 for sub-stations, transformers, cables and mains (to be repaid within 30 years), and £1,000 for working capital (to be repaid in 10 years).

In the provisional order for the amalgamation and extension of the Motherwell and Wislaw Burghs there is a strange clause, which provides that the gas and electricity undertakings of the burghs respectively shall from and after the commencement of this order be held, maintained and carried on by the Town Council as separate undertakings, provided that if at any time after the commencement of this order the Town Council shall deem it expedient in the interest of economical management that the said gas or electricity undertakings respectively should be combined, they may execute all such works and do all such things as may be necessary for effecting such combination, and from and after any such combination the undertakings so combined shall be deemed to be one undertaking. If the Town Council shall combine the said electricity undertakings into one undertaking, the provisions of the Motherwell Electric Lighting Order, 1895, and by-laws or regulations made in pursuance of the said order shall apply to the said undertaking. The area of supply of electricity by the Town Council shall be the burgh.

Coventry Corporation are promoting a Bill for (inter alia) power to purchase land in Toleshill for the erection of electricity works, and also to lay lines in private streets, to refuse supply to consumers whose payments are in arrear, to construct sub-stations under streets, &c. It is proposed to borrow £125,000 for the erection of the generating station (repayable within 40 years) and £375,000 for electrical machinery (repayable in 25 years), and it is also sought to apply the surplus revenue in any year, after the creation of the statutory reserve fund, to the purposes of the electricity undertaking, including the formation of a fund for working capital.

The Masham Urban District Council are promoting a Bill for the purchase of the local electricity and gas undertakings, with power to purchase electrical energy in bulk. The maximum price for the supply of electricity is 13s. 4d. for any quantity up to 20 units per quarter and 8d. per unit thereafter. Authority is sought to undertake wiring work, the sale and hire of electrical fittings, motors, &c. Where a gas consumer desires to have a supply of electricity, the Council may fix a minimum charge for such supply. For the money to be raised for the purchase of the electricity undertaking a period of 30 years is required for repayment, and any sinking fund may be used instead of borrowing.

The Halifax Corporation Bill confers powers for the incorporation of Brighouse, Queensbury, Shelf, Hipperholme, Southowram, Elland, Greetland, Norwood Green and Coley within the borough boundary, and the existing electricity supply powers are to be applied to the added area. Authority is sought to enter into agreements for taking a supply of electricity in bulk, to discontinue supply in certain cases, to supply electrical energy to any railway, tramway, canal, &c., partly within and partly beyond borough boundary, to accept transfers of electric lighting undertakings, to authorise special charges in cases where consumers have separate supply of power (whether electricity, gas or other source of power), &c.

In the Bill of Tredegar Urban Council powers are sought to erect a generating station and to supply electricity and to purchase electricity in bulk. The Council may also sell, let for hire and fix electric lamps, meters, lines, motors, &c., may make by-laws as to wires and fittings and make provision for cases where premises have a separate supply of power (whether electricity, steam or gas). Authority is given to attach brackets to buildings, to lay mains in private streets, to employ overhead lines, to allow discounts, &c.

The Blackpool Improvement Bill seeks to incorporate Thornton urban district within the borough boundary and to extend the area of electricity supply to the added area; but for 10 years the charge for electrical energy shall be 10 per cent. above that in the existing borough.

In an Omnibus Bill, Cardiff Corporation seeks powers to sell, let on hire, and fix electric lamps, wires, fittings, motors, &c., and to exempt apparatus let on hire from distress of execution. The Corporation shall keep separate accounts of this work, and adjust charges so as to meet the costs and expenses incurred thereon.

The Bristol Corporation Bill extends the electric supply area to areas proposed to be added to the borough, including Kingswood and Warmley, Bishopsworth and portions of the rural district of Keynsham. The Kingswood Provisional Order of 1904 is to be repealed, the Corporation may lay electric lines through Keynsham and Saltford and acquire other electrical undertakings by agreement.

In the Bill promoted by the Edmundsons Electricity Corporation, the Urban Electric Supply and the Twickenham and Teddington Electric Supply Companies power is sought to charge a maximum price of 1s. 2d. per unit for electrical energy supplied by the companies. In the preamble it is stated that the capital expended by the companies exceeds £1,300,000. Owing to the great cost of carrying on the undertakings the revenue obtainable, under existing powers, is either insufficient to meet the working expenses in the case of certain of these undertakings or is barely sufficient for that purpose in the remaining cases. It is proposed that if the maximum price is fixed at 1s. 2d. per unit a sliding scale should be adopted which would entitle the companies to pay a dividend of 6 per cent. per annum on the capital employed when the price charged to consumers is 1s. per unit or over, and that an additional one-half per cent. "for each halfpenny by which the highest price charged in one year is less than 1s. per unit."

In the preamble of the Bill of the South Wales Electrical Power Distribution Company it is stated that the company having never paid any dividend on its share capital and by reason of its present financial position is unable to raise further capital except by the issue of loan capital ranking pari passu with the prior lien debenture stock. Moreover, the interest on the £200,000 five per cent. debenture stock issued has been paid by deferred warrants carrying interest at 5 per cent. per annum, and at present there are deferred warrants outstanding of the nominal value of £95,000, and the interest on these warrants amounts to £37,750. It is therefore proposed to empower the company to issue £500,000 five per cent. prior lien debenture stock in addition to the £318,148 prior lien debenture stock authorised in 1906 (but not yet issued), and to create and issue such amount of five per cent. debenture stock as may be required, and to issue to holders of deferred warrants £1 of debenture stock for every £1 secured by the warrants in satisfaction and discharge of the amounts secured by such warrants as regards principal and interest. The Bill also empowers the company to issue debenture stock certificates to bearer.

The Coal Rebate.

The Coal Controller has issued the following "prescription" to electricity undertakings under the provisions of Clause 5 of the Coal (Pit's Mouth) Prices Order and Direction, 1919:—

In the case of coal delivered during December, 1919, the amount of coal in respect of which the deduction of 10s. per ton may be made shall be ascertained by reference to the proportion that the quantity of electricity supplied for domestic or household purposes during the third quarter of 1919 bears to the total quantity of electricity supplied during the same period, and shall be determined accordingly.

In the case of coal delivered between Jan. 1, 1920, and March 31, 1920, the amount of coal in respect of which the deduction may be made shall be ascertained by reference to the proportion that the quantity of electricity supplied for domestic or household purposes during the fourth quarter of 1919 bears to the total quantity of electricity supplied during the same period.

In any subsequent quarter the amount of coal in respect of which the deduction may be made shall be ascertained by reference to the proportion that the quantity of electricity supplied for domestic or household purposes during the corresponding quarter of the previous year bears to the total quantity of electricity supplied during the same period.

In respect of sums so deducted, an allowance shall be made to each domestic or household consumer at the end of each quarter which shall be at that rate per unit which results from dividing the total weight of coal (in tons) used in the previous quarter by the total units supplied in such previous quarter, multiplying the quotient by 120 (the result being in pence), less such percentage in respect of expenses as may from time to time be approved by the Controller of Coal Mines. The first allowance shall be given to the consumers at the end of the first quarter of 1920, and shall take account of deductions then actually made from the price of coal delivered between Dec. 1, 1919, and March 31, 1920. Any surplus or deficiency shall be carried forward to the next quarter.

An explanatory memorandum on the above "prescription," which was prepared by a committee consisting of Mr. Roger T. Smith, president of the Institution of Electrical Engineers, and representatives of the I.M.E.A. and other associations representing the various supply companies and authorities, has been issued by the Board of Trade to the electrical undertakings concerned. The memorandum has been approved by the Coal Controller, and gives formulæ for the calculation of the rebate to be made, the issue of certificates, &c. We refer to this editorially.]

An amended Admiralty notice relating to WIRELESS DIRECTION-FINDING (D.F.) STATIONS has been issued. The methods of asking for and giving bearings and the waves to be used will shortly be standardised by international agreement, and the particulars of the D.F. stations will eventually appear in the international list of radiotelegraph stations, but in the meantime each country publishes regulations governing the use of its own D.F. stations.

Artistic Showcards.

Two new Mazda showcards of the British Thomson-Houston Company strike a delightfully fresh note in lamp publicity. Both showcards are printed in 9 colours, measure 22 in. by 15 in., are provided with eyelets for hanging, and are stiffened with brass at top and bottom. One showcard appeals to the domestic buyer, and naturally "features" the vacuum type Mazda Lamp as The Electric Lamp for the Home. The other symbolises strength—the physical and illuminating strength of the Mazda half-watt type lamp, and the symbol employed is the British oak. As will be seen from our illustration the artist has succeeded in portraying a most convincing oak, signifying in every ripple of its gnarled and twisted trunk, the characteristics of sturdiness and longevity which it shares with the Mazda half-watt type lamp.

Strength
As British as the Oak
MAZDA
Half-Watt
Type
ELECTRIC LAMPS
British Made in Rugby England.

The Gattie Transport Scheme.

We have received a long letter from Mr. Roy Horniman, acting chairman of the New Transport Company, pointing out that in summarising the report of the Committee on the Gattie scheme the Press unanimously stated that the scheme had been rejected because it would cost over £300,000,000 to establish it. Mr. Horniman points out that counsel, in summing up the argument for the Gattie scheme, dealt with this particular fallacy, showing that a London goods clearing house could be set up and thoroughly tested for a comparatively small sum, and that the very large sum which had been several times mentioned by the other side would not be extended until the profit and economy of the scheme had been generally shown. Mr. Horniman also points out that the paragraph of the report which states that Mr. Gattie was emphatically desirous of his scheme being adopted in its entirety only refers to an entire clearing house, and not to the system being applied to the country as a whole. Mr. Horniman concludes by saying that it is difficult to see how such a report can have been published in face of the immense weight of evidence in favour of the Gattie scheme, in order to disprove which practically no figures, documents or facts were produced.

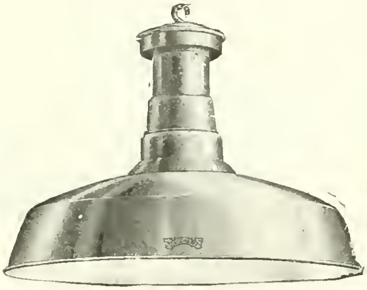
British Industries Fair.

The arrangements for the Birmingham section of this Fair, which will be held at Castle Bromwich Aerodrome from Feb. 23 to March 5, are approaching completion. The exhibitors number 650 and 100,000 ft. of space has been taken. Plans for hospitality and entertainment to overseas buyers have been made. The chief features will be general hardware and engineering, the latter being represented by 200 firms. All classes of brass foundry are to be adequately covered, particularly in relation to hot and cold water, electric light and gas fittings, and also builders' ironmongery, electrical radiators, cookers and other electrical appliances in domestic use. The section devoted to chandeliers, electric light fittings and accessories, and lamps of all kinds, including electric pocket lamps, is extremely well covered, and interesting developments are promised by enterprising firms. The tube industries, which cater largely for the electricity supply and gas undertakings, promise a big display.

The Dispersive Mazdalux Reflector.

A new pattern of Mazdalux reflector, possessing several features which distinguish it from previous types, has recently been developed by the British Thomson-Houston Company. This is known as the dispersive Mazdalux reflector. It is made in four sizes, from 13 in. to 22 in. in diameter for half-watt lamps of from 60 to 1,500 watts. For uniform illumination these dispersive units should, the makers inform us, be spaced a distance apart equal to 1¾ times their height above the working plane. The angle of "cut-off" is 85 deg so that this reflector is particularly suited to conditions requiring the illumination of vertical surfaces.

As will be seen from the illustration, the dispersive Mazdalux is a complete unit in itself, the reflector being provided with a top housing and suspension hook. A bayonet, Edison screw or Goliath screw lampholder is also included, according to the size of lamp. The reflector is made of sheet steel, stiffened with a beaded lower edge, and accurately formed to give the dispersive distribution defined above. The interior is finished with white vitreous enamel, which, in addition to providing a high reflecting surface, does not readily collect dust, and is easily cleaned. French grey enamel carefully stoved on is employed to protect the exterior of the reflector. It will also be noticed that the reflector has a deep skirt, the object of which is to increase the dispersion of the light rays to a greater extent than in some other types of half-watt lamp reflectors. This is of importance, as the concentrated form of the half-watt lamp filament is in the ordinary way an obstacle to wide distribution. We understand that these dispersive Mazdalux reflectors are supplied in a modified form (known as the "Dispersa" lantern), with weather proof housing made of cast iron for outdoor use.



Dispersive Type Mazdalux Metal Reflector for Industrial Lighting.

Japanese Steel Mill Equipment.

An order for what is said to be the First Steel Mill Electric Motor ever built for a large reversing slabbing mill has recently been placed with the Westinghouse Electric & Mfg. Company by the Imperial Steel Work of Japan. The order is the second for electric steel mill equipment received by the Westinghouse Company from the Imperial Works. The equipment in question will be used with a slabbing mill with which it is expected to roll steel ingots weighing up to 25 tons, down to slabs having a maximum dimension of 17 in. by 46 in., and a minimum of 4 in. by 20 in. The motor will be of the double-unit reversing slabbing mill type, of 5,800 H.P. continuous capacity and 17,600 H.P. momentary. It will have a speed range of 47 to 90 revs. per min., and will use direct current at 700 volts. Power for the motor will be furnished by a motor-generator consisting of two 700-volt direct-current generators driven by one alternating-current motor. The generators, which will be of 3,000 kw. capacity each, will operate at 368 revs. per min., are to be connected in series with the reversing motor, and will be designed to stand the same momentary current peaks that it does. The motor which drives the two generators will be of the eight-pole wound-rotor induction type, and will be of 6,250 H.P. capacity. It will take three-phase 25-cycle current at 3,300 volts. A 150,000 lb. cast-steel flywheel is to be used with this set. Control for both the reversing motor and the motor generator set will also be furnished.

Another part of the equipment will consist of a three-unit exciter set, consisting of two direct-current generators driven by an alternating-current motor. One generator will be of the constant potential type and rated at 62 kw. 250 volts. The other will be series would and rated at 37½ kw., 0·250 volts. This motor will be of the squirrel-cage three-phase induction type, and rated at 125 H.P., 440 volts, 25 cycles. The speed of the set is 720 revs. per min. Other apparatus will consist of a blower driven by a 50 H.P. 440-volt three-phase 25-cycle squirrel-cage induction motor; an air washer and a 165 k.v.a. three-phase 25-cycle 440-volt/3,300-volt transformer for supplying the blower motor and exciter set. A pump for circulating water will also be supplied, driven by a 7½ H.P. d c. 1,200 revs. per min. 230-volt shunt-wound motor.

The "Kramer-Vaporiser" for Starting of Petrol Engines.

In cold weather, or when using poor quality fuel, the starting up of petrol engines for lorries, motor cars, aeroplanes, &c., as well as stationary petrol engines in exposed buildings, more often than not causes considerable difficulty. The following methods which are commonly employed in overcoming these starting troubles, are not particularly effective or scientific: (1) Repeated cranking-up with the starting handle or excessive application of the self-starter. (2) Flooding the carburettor. (3) Priming the cylinders with petrol. (4 The application of hot rags or boiling water to the exterior of the carburettor and induction pipe. The scientific way of ensuring rapid ignition is to apply heat inside the induction pipe, and so producing a volume of hot fuel vapour, which under compression in the cylinders is instantaneously exploded by the spark on the plug points.

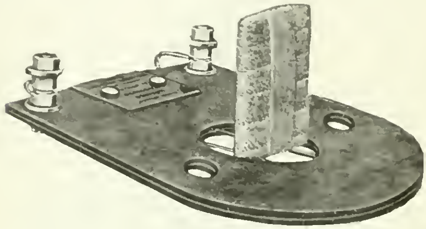


Fig. 1

The "Kramer-Vaporiser," which has been placed on the market by the General Electric Company, is a simple device to effect this. It consists of an enclosed electrical heating element placed within an asbestos cushion (*see* Fig. 1). This absorbent cushion is mounted on the packing material between the induction pipe and carburettor flanges, the asbestos cushion projecting upwards into the induction pipe. On the suction stroke of the piston, the cushion absorbs the liquid fuel spray injected by the carburettor. This spray is immediately vaporised on coming in contact with the electrically heated cushion, thus producing the necessary volume of hot fuel vapour for starting the engine.

There are a large number of reasons why it is claimed the "Kramer-Vaporiser" should find a wide application to petrol engines, besides the fact that it fulfils its function most expeditiously and satisfactorily. Some of these reasons are as follows: It can be made to suit any make of petrol engine, and any make of motor car or aeroplane (the only information required being the inside diameter of induction pipe, distance between centres of bolt holes in flange, and voltage of accumulator or particulars of self-starter), it can be wound for use with separate 4, 6, 8 or 12-volt accumulators, or it can be run off a self-starting or car-lighting equipment, it consumes only about 30 watts, generates hot vapour within 90 seconds, will start an engine about 400 times on a single charge of the vaporiser accumulator if this has a capacity of 40 ampere-hours at 12 volts, it weighs only about 3 ozs., including the flange, and is practically indestructible, does not interfere with engine inspection or repair, and is merely a substitute for the present flange packing, and therefore easily fitted, this being effected by removing the bolts clamping the flanges of the induction and carburettor pipes, replacing the existing packing by the one supplied with the vapouriser and inserting it with the cushion placed, as shown in Fig. 2. The flanges are then bolted together again, and the two terminals connected by means of a flexible cord to a combined switch and pilot lamp, and accumulator, as shown in Fig. 3.

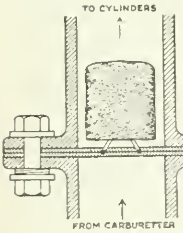


Fig. 2.

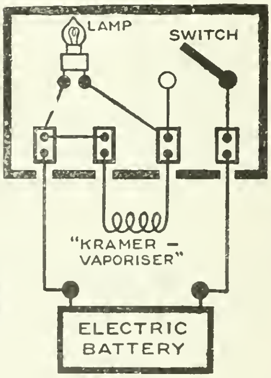


Fig. 3.

Before inserting the vaporiser into the induction pipe, it is advisable to steep the asbestos cushion in petrol or benzol. After it has been in use once or twice, it will always contain sufficient fuel to vaporise immediately after it is switched on.

Another use for the "Kramer-Vapouriser" is to obtain better and smoother running combined with increased mileage per gallon of fuel on motor cars by keeping the pad continuously heated—this obviously necessitating the provision of an accumulator of considerably larger watt-hour capacity or preferably the connection of the vaporiser to an electric dynamo lighting set. The increased mileage obtained is due to the fact that the thicker the asbestos cushion inserted, and the greater the apparent obstruction, the purer the fuel vapour and the less wastage of liquid spray reaching the combustion chambers. It should also be pointed out that the absorbent cushion acts as a vaporiser in itself, without the heating element, and that if an absorbent pad be put into the induction pipe it does not obstruct the passage nor interfere with the running of the engine, but on the contrary results in smoother running, as the spray is not sucked in neat into the cylinders, but in a vaporised form.

In a test on a 25 h.p. motor car, fitted with a "Kramer-Vapouriser," the asbestos cushion was of a cylindrical shape, and of the same diameter as the induction pipe, viz., 1¼ ins., thus apparently obstructing the whole passage of the induction pipe. An extra air inlet was fitted above the pad. The car started up instantaneously, and there was no reduction in speed or power, the asbestos pad acting in a similar way to the well-known Lanchester wick carburettor.

Legal Intelligence.

Workmen's Compensation.

In the Bow (London) County Court on Monday, Ed. Hauxwell, applied for an award of compensation against the Charing Cross, West End & City Electric Supply Company. Applicant was an assistant engine driver at the company's power station at Marsh-lane, and on Dec. 1, 1918, a ladder fell, causing him to fall into the pit, and his right wrist was broken. At that time he was earning £4 13s. 2d. a week. He went back at the end of March, and was found light work at £3 6s. 8d. a week, and his compensation was lowered from 25s. to 10s. a week for eight weeks. Then he was put back on to his old work for a time, but found himself incapable of doing it. Respondents discharged him, but three days later he was taken back as an assistant box cleaner at £3 10s. a week. He claimed that since July he had lost the difference between the £3 10s. a week and the £4 13s. 2d. he had originally earned. Respondents contended that the high wage earned by the man was only caused by his temporarily doing some very long overtime, but it was of such short duration that it would not be fair to include it in an average for compensation. They also suggested that the man had recovered sufficiently to do his old work, and that the reason for his discharge was because he absented himself for days without letting them know why. They agreed to take him back on the representations of his union, but they could not then give him his old job, as a number of their old employees who had been in the Army had been demobilised, and they had to carry out their promise to find them jobs. Appellant had only been taken on during the war, and was not entitled to the same consideration as the soldiers.

Judge Graham reserved judgment.

Hodges v. Webb.

On Monday Mr. Justice Peterson commenced the hearing of this action in which plaintiff claimed an injunction to restrain defendant from wrongfully interfering or attempting to interfere with his employment and his right to dispose of his labour as he willed.

Mr. Hughes, K.C., said that plaintiff was an electrician foreman in the employment of Messrs. Tyler & Freeman, and from some time in August last he had been working on a job at Watford. Plaintiff was in charge of 12 men, and until October 13 everything had been carried on in a peaceful manner. He had formerly been a member of the Electrical Trade Union, but some time ago he had ceased to be a member of that union, and became a member of the National Association of Supervising Electricians. Defendant was a secretary of the Electrical Trade Union, and apparently he was not satisfied that the plaintiff should remain outside that union. The plaintiff's complaint was that defendant coerced his (plaintiff's) employers into dismissing him by calling out on strike the men who were working under him, and by threatening to keep them out until he was dismissed. No complaint had been made by the men of not receiving the trade union rate of pay, and all went well until October 13, when the defendant, with other officials of the E.T.U., went to the works where plaintiff was employed and said: "Have you got an E.T.U. ticket?" Plaintiff replied: "No, I am a member of the N.A.S.E," and the defendant then said: "Well, you will have to get off the job." After further conversation defendant called the men working under plaintiff off their job, and they went on strike. There were four men, in addition to the plaintiff, who were not members of the E.T.U. Three of them at once took up E.T.U. tickets, and the other man remained on with plaintiff. He was not a wireman, but merely an assistant. These two "carried on" for 10 days, when the assistant also had to leave on account of a threat of a strike. Correspondence with Messrs. Tyler & Freeman then ensued and finally plaintiff was discharged.

Evidence was given by Mr. Tyler and others, but the hearing had not concluded when we went to press.

Commercial Topics.

Capital Issues in 1919.

According to statistics recently prepared by the London Joint City and Midland Bank, the amount of new capital issues by electric light and power companies during 1919 was £3,604,088, compared with £1,561,760 in 1918; by iron, coal, steel and engineering enterprises, £24,635,948, against £15,513,073; by telegraph and telephone companies £5,455,000, compared with nil in 1918; and by tramway and omnibus undertakings, £1,449,247, against £133,200.

* * * *

Clearing Office for German Debts.

The Clearing Office for enemy debts provided for in the Treaty of Peace with Germany has been established, and Mr. E. S. Grey, Senior Official Receiver in Bankruptcy, has been appointed Controller, to whom communications should be addressed at Cornwall House, Stamford-street, London, S.E.1. In order to advise the Controller in the operation of the Clearing Office the following committee has been appointed:—Sir Wm. Plender, C.B.E. (Chairman), Mr. Geo. Watson, Mr. O. R. A. Simpkin, C.B.E. (Public Trustee), and Mr. H. A. Payne, C.B. (Board of Trade). Particular branches of industry and commerce are being invited to nominate representatives to confer with the Controller.

* * * *

Trade With Central Europe.

A Command Paper, which was issued on Monday, defines the conditions on which British trade with Germany and certain other countries may now be resumed. British traders are urged to make every effort to secure a proper footing in Central Europe. Any goods may be sent to Germany without license, except goods on lists "A" and "B" of prohibited exports

Any goods may be imported from Germany, and paid for, without license, except goods whose importation from all foreign countries is prohibited. The import prohibitions established during the war have been temporarily suspended pending either reversal of Mr. Justice Sankey's judgment or legislative action to secure powers to impose restrictions. It is stated that "Importers should clearly understand that in the event of these powers being conferred by Parliament, or in the event of the judgment being reversed on appeal, licenses to import restricted goods will not be granted merely on the ground that the goods had been ordered between the date of the judgment and that of the re-establishment of the restrictions."

Other transactions of a commercial or financial nature with firms in Germany are permissible without license, provided they do not involve payment or receipt of money arising out of pre-war transactions, &c.

As regards Turkey, Bulgaria and the territories previously includde in the Austro-Hungarian dominions, the British regulations are similar to those which apply to Germany.

* * * *

Changes in Patents and Designs Law.

The Patents and Designs Act, which became law on Dec. 23, 1919, makes numerous alterations in the British patent law, of which the following are those of most general interest to inventors and patentees:—

The term of a patent is increased to 16 years. This applies to all patents on applications dated Dec. 23, 1905, or later. The fees (if any) to be paid for the 15th and 16th years are not yet fixed.

The period of provisional protection is increased to nine months. Any application, therefore, accompanied by a provisional specification and lodged subsequent to March, 1919, may be completed within nine months of the date of application, or, by the payment of a fine, within 10 months.

A patentee (other than a late enemy) who has by reason of the war suffered loss or damage (including loss of opportunity of dealing with or developing his invention, owing to his having been engaged in work of national importance connected with the war), may apply in a simpler and cheaper manner than hitherto possible for a prolongation of the term of his patent, and the Court, in considering the application, may have regard solely to such loss or damage.

Any person who has acquired or may acquire by assignment, licence or the like, any interest in a patent or design, must register his interest at the Patent Office.

The grounds on which the grant of a patent may be opposed are enlarged, and such grant may now be opposed on the ground that the invention has been published in any document published in the United Kingdom prior to the application.

Under certain conditions, publication of an invention in a Paper read before a learned society does not invalidate a patent subsequently applied for. This provision, however, is fraught with the greatest danger, and in a circular issued by the Chartered Institute of Patent Agents it is recommended that this should not be taken advantage of without professional advice.

No person other than a registered patent agent may now practise, describe or hold himself out as a patent agent.

The following provisions, though not yet in force, are also of interest:—

At any time after the sealing of a patent the patentee may request the Comptroller to endorse the patent with the words "Licences of right." The Comptroller, on being satisfied that the patentee is not precluded from making such request, will so endorse the patent, and thereafter the patentee will only have to pay half the normal renewal fees, but any person who wishes to use the invention will have the right to a licence on terms to be settled by the Comptroller in default of agreement between such persons and the patentee.

Drastic provisions as regards the grant of compulsory licences and revocation have been substituted for sec. 27 of the old Act.

Electricity Supply.

The demand for electricity in BRIERFIELD is increasing, but installation work is delayed owing to the scarcity of cables and meters.

Application has been made by DARWEN Council for sanction to borrow £27,695 for converting plant and cables in order to obtain a supply of electricity in bulk from the Lancashire Electric Power Company.

WIGAN Council has applied for sanction to borrow £12,050 for a 1,500 kw. rotary converter, &c., at Bradford-place station, and a 50 kw. rotary converter at the Pemberton sub-station.

An increase in salary of £200 a year, making £1,000, has been granted by Blackburn Town Council to Mr. P. P. Wheelwright, the Borough Electrical Engineer.

GREAT HARWOOD Council have applied to the Board of Trade for an extension of time for carrying out its Electric Lighting Order, and a committee has been appointed to make arrangements for an electric supply scheme.

The Secretary for Scotland has authorised GLASGOW Corporation to borrow a further £1,000,000 for the execution of capital works under their Electric Lighting Order of 1890, raising the authorised borrowings to £5,071,478.

BISHOP'S STORTFORD Council has protested to the Board of Trade against the application of the Bishop's Stortford, Harlow & Epping Gas & Electricity Company for an order to allow the charge for electric current to be increased to 1s. per unit.

The Fuel Controller's restrictions upon the supply of electricity in HULL have been withdrawn, and in future the supply of electrical energy for industrial purposes will be unrestricted, while cinemas may give matinees on Thursdays and Saturdays.

ALDERLEY EDGE Urban Council has adopted the sensible policy of appointing several ladies upon the Housing Committee, for the purpose of considering the plans of new houses, the internal fittings and arrangements, and the provision to be made for lighting and heating.

It is proposed to put down a new power station of 10,000 kw. capacity which will be controlled by a joint generating board to be appointed by the MEXBOROUGH Urban Council and the Yorkshire Electric Power Company. The proposed site for the new station is in Adwick, near the Mexborough boundary.

LIVERPOOL TRAMWAYS and Electric Power and Lighting Committee recommended the City Council to divide the work of the committee, and to constitute a new committee. It is proposed that one committee shall deal entirely with tramway matters, and the other with electric power and lighting.

SOUTH SHIELDS Electricity Committee proposes to apply for sanction to undertake a scheme for extensions of the electricity undertaking in order to meet the increased demand for electrical energy. There was a deficit on the past year's working of £7,385 13s. 6d., which will be met out of the reserve fund.

In order to meet the needs of the immediate future, LEICESTER Tramways and Electricity Committee propose to instal, at a cost of £12,000, a number of static transformers at the Newarke-street sub-station of a total capacity of 6,000 kw., to balance the whole of the single-phase load on to the three-phase mains.

BLACKBURN electric supply department has received applications from several cotton mills in various localities for the supply of current which will necessitate the laying of new mains. The applications, as well as the request for wiring the whole of the Poor Law Institution buildings, are being dealt with by the new Electrical Generating Station Committee.

BARNARD CASTLE and BISHOP AUCKLAND were last week deprived of gas owing to the shortage of coal. The Cleveland and Durham County Electric Power Company, whose cables run through the main streets of Bishop Auckland, are willing to extend to the side streets if sufficient guarantees can be obtained.

According to the CHESTERFIELD Electricity Committee, the amount of electric current which will be consumed for private lighting during the current financial year will be about 12 per cent. of the output, and that the saving expected from the reduction in the price of coal is less than £70. It is therefore proposed to make a 75 per cent. increase over pre-war in the scale of charges.

BUXTON Corporation has decided to carry out alterations to and extensions of the electric generating plant and mains, for which application has been made to borrow £24,379. It is proposed to substitute gas engines for the existing steam plant at a cost of £15,775, to extend the mains and network pillars at £2,763, and to lay new distributing cables and erect eight network pillars at £2,800.

Ald Higham informed ACCRINGTON Council last week that the poor coal now being supplied accounted for the large consumption per unit. In spite of these drawbacks, he believed they would come out on the right side. They had got the permission of the Electricity Commissioners to carry out extensions, and they had a scheme which would give them something like 20,000 H.P.

The Yorkshire Electric Power Company proposes to lay mains through the most important towns of SOUTH YORKSHIRE in accordance with their statutory powers, but in the Dearne Valley, where the Dearne District Electricity Committee also possess electric supply powers, the constituent Councils (Wath and Wombell) are asking the Government "to defer or suspend the company's powers until the Government scheme for the supply of electricity is defined."

A memorial tablet of all the employees of the MANCHESTER Corporation electricity works who were killed in the war was unveiled at the Stuart Street station on the 11th inst. by the Lord Mayor, Alderman Tom Fox. The tablet, which is of bronze, and is in a prominent position on a wall in the works, has been erected by the men to "the honoured memory of their comrades," who numbered 25. Altogether 212 men joined up from the Stuart-street works.

NELSON Town Council has decided to accept the tender of the Brush Electrical Engineering Company for the supply of two Ljungstrom turbo-generators. Councillor Cooke explained that the capacity of their plant was only 800 kw., and they were running regularly at over 900 kw. In the future they were expecting Colne taking a million units for their own use. At present they had applications for the running of 1,700 to 1,800 looms by electricity. The present machines used 28 lb. of steam per kilowatt; but the Brush machinery would run at between 12 lb. and 13 lb. of steam. The cost of the two machines would be £47,640.

In regard to the Tummel water power scheme, particulars of which were given in a recent issue, DUNDEE Electricity Committee has asked Mr. C. S. Meik and Mr. W. J. G. Binnie to state whether they would be prepared to arrange contracts for the works suggested on the basis of their estimates, and failing this whether they would be prepared to furnish detailed plans and specifications on which their estimates are based in order that these might be examined. The Chief Electricity Commissioner is also to be approached, and, if necessary, the Ministry of Transport, with a view to ascertain whether and to what extent they would be prepared to assist the scheme in the matter of finance, control of material, or otherwise.

Having considered the report of Mr. M. E. Lacey, on the future of the electricity undertaking, BURNLEY Electricity Committee recently recommended the Council to obtain sanction to borrow £75,000 for extensions, including the installation in the existing station of an additional 3,000 kw. turbo-alternator, with three water-tube boilers, economisers, cooling tower, steam and water piping, a rotary converter, &c. Even when the proposed extensions are carried out the Committee will still be unable to supply all prospective consumers. There is, however, a scheme on foot for the establishment of a power station outside the borough. During the discussion at the Council meeting last week it was stated that intending consumers in the Rosegrove district had been waiting 12 yeasr for a supply. The recommendation was adopted.

In view of repeated increases of wages and in the cost of materials the Electricity Committee cannot make a reduction at present in the prices charged for electricity. The Committee has adopted the revised list of basic rates to be paid to various classes of employees in electrical undertakings.

It is to be hoped that there will be no delay in putting into force the provisions of the Electricity (Supply) Act, but before this can be done the existing powers of the Board of Trade must be transferred by an Order in Council to the Ministry of Transport, and when this is done the Electricity Commissioners will be appointed. According to the "Scotsman" the Minister of Transport has practically decided upon the Commissioners. Under the Act the maximum number of Commissioners is five, and in view of the great amount of spade work which will be necessary at the beginning five appointments will be made. It is generally accepted that Sir John Snell, who has acted as chief adviser to the Government in connection with the Act, will be appointed Chief Commissioner. Two of the other four will be engineers, one with municipal experience and the other with company experience, and the remaining two will be financial and legal experts. The first duty of the Commissioners will be the mapping out of the country in definite regions, and the holding of inquiries into the various local needs and resources. It is intended to divide Scotland into two regions, whose respective centres will be Edinburgh and Glasgow, although the question of the formation of a northern region centreing round Nairn has been under consideration.

LOUGHBOROUGH Corporation has appointed Mr. C. H. Wordingham consulting engineer in connection with a prospective scheme for the extension of the electricity works at a cost of about £150,000. Mr. Wordingham and Mr. J. H. Rider are the consulting engineers for the projected central supply station for the East Midlands, which is considered likely to create difficulties for the Loughborough extensions. Leicester is the nearest large station to Loughborough, but the Loughborough Electricity Committee is of opinion that no reliance should be placed on any proposal for obtaining assistance from Leicester, and an additional supply is urgently required to meet the requirements of present and future consumers. Ald. Bumpus, chairman of the Electricity Committee, states the matter is extremely urgent. There is not only a largely increased demand for current, but, in his opinion, it is very desirable that some portion of that demand should be supplied at the earliest possible time. The recommendations of his Committee were the first step in a very heavy expenditure, but that expenditure was inevitable. There was no other source of electricity for manufacturers, except by the extension of these works. Leicester was in a worse position than Loughborough; their own manufacturers could not get power, and Nottingham was at least as bad as Leicester. The Electricity Commissioners were averse to extensions to small plants, but, on sufficient reason being shown, it was possible that the aversion might be overcome. They could not expect to draw any current from the projected central station for four or five years, and to secure the necessary power in Loughborough an expenditure of anything up to £150,000 would have to be incurred.

Electric Traction.

ILFORD Urban Council has decided to purchase six Orwell electric vehicles at £1,325 each.

It is announced that the employment of a train "hustler" at the Victoria station of the METROPOLITAN DISTRICT RAILWAY has been such a success that a similar experiment is being made at Charing Cross station.

The LANCASHIRE AND DISTRICT FEDERATION OF TRAMWAY AUTHORITIES has protested against the action of the National Tramways Industrial Council in agreeing to pay time and half rates for the extra bank holiday following Christmas Day.

SALFORD Corporation has approved the promotion of the Bill to authorise the construction of additional tramways, to provide and run motor omnibuses, also for further powers for the electric lighting and other municipal undertakings.

During the current year SHEFFIELD tramways department will spend about £200,000 on new tramcars and the completion of the new depot at Crookes. Twenty-five new cars were commissioned late last year, three more have been put into service since Jan. 1, and there are still 47 to come before the end of the year.

At a public meeting at ST. ANNE'S-ON-THE-SEA a resolution was passed approving of the Council's application to Parliament for a Bill to acquire the undertaking of the Blackpool, St. Anne's and Lytham Tramways Company (the purchase price of which is £140,000), to empower them to run tramways, omnibuses, &c.

SWANSEA ratepayers at a meeting called to consider the Corporation's Bill, expressed strong objection to clauses providing for the establishment of motor omnibus services, and urged that the tramways should be extended. The Town Clerk pointed out that the cost of extending the tramways (£30,000 a mile) was now prohibitive.

On a vote the amendment to delete the clause was defeated, but a second amendment deleting all clauses relating to the provision of transport facilities for any district outside the borough was carried.

The question of the purchase of the undertaking of the LANARKSHIRE tramways is at present under consideration by a committee of the County Council. At a recent conference between representatives of the Council and the other local authorities interested it was decided not to entertain the company's offer to sell, but if the company thought fit to submit an amended offer it would be laid before a future meeting. Sir Thomas Munro, county clerk, advised they should not buy on the terms asked. The County Council could only buy in co-operation with the burghs, and in 1928 they would not have the same difficulty as they had now. The members of the Committee were nearly all in favour of purchasing, but not on the suggested terms. It was pointed out that all the members had not full information as to the proposed terms of sale, and it was agreed to defer discussion to a meeting of the whole Council in Committee.

Representatives on the NATIONAL JOINT INDUSTRIAL COUNCIL FOR TRAMWAYS of the employers in Area D (Yorkshire, Lincolnshire and North Derbyshire) were recently elected as follows, the first six being representatives of municipal undertakings and the other four of company concerns: Messrs. A. A. Blackburn (Huddersfield), A. Smith (Keighley) R. H. Wilkinson (Bradford), Bamforth (Doncaster), J. W. Hame (York), E. S. Rayner (Hull), H. L. White (Great Grimsby), E. A. Paris (Dewsbury), E. Nicoll (Barnsley), and W. McGibbon (Mexborough). Alderman H. Brown (Leeds), Mr. A. R. Fearnley (Sheffield), J. B. Hamilton (Leeds), and H. England (Wakefield) are ex-officio members. Mr. R. R. Hubball (Leeds) was chosen secretary and treasurer, and it was recommended to the Joint Council that Alderman Brown be appointed chairman of the Area Council. The employees' representatives have also been elected, and these include Mr. F. Thraves (Sheffield) as deputy chairman, and Mr. H. Clay (Leeds) as secretary.

A proposal to increase the tramway fares has been under consideration by the GLASGOW Tramways Committee for some time, but Corporation decided last week not to make any increase during the current financial year, which will end on May 31. This decision was opposed by the Convener (Mr. Kelly), who reviewed the history of the tramway undertaking. On the outbreak of war in 1914, all extension work was stopped, additions to equipment could not be made, wages began to increase, and the cost of all necessary materials rose enormously. The wages bill was £1,143,000 a year, against £441,000 for the year ended May, 1914, and they were now paying for materials required for the track, electrical equipment, cars, and indeed everything they used, from two to four times pre-war prices. The cost of renewing one mile of single track was £10,270 against £3,960 in 1914. The revenue had also shown a large increase each year, but the increase in wages and materials and rates and taxes had been in far greater ratio since 1914. Taking the cost of renewing one mile of single track at £10,000, to renew the 80 miles of track to be dealt with would mean an outlay of £800,000 in four years. The last accounts to May last showed that they had then £312,451 for the renewal of permanent way. By May, 1923, they would have spent £800,000 on the 80 miles, leaving £62,000 against depreciation then existing. £137,394 was the figure they proposed to take out of revenue for each of the next four years, and one-fourth of £137,394 was the sum debited in the trading account for the three months to August last, which showed a loss of £19,435. There was also debited in the account one-fourth of the sum equal to that taken from revenue for depreciation of plant and rolling stock. There had been no improvement during the past three months, and if matters were allowed to go on as at present the year's accounts to May next would show a serious loss.

Imperial and Foreign Notes.

The Federated Malay States railways will provide electric light installations at all stations where the night mail stops.

Kerang (Victoria) Shire Council proposes to borrow £6,500 for the equipment of electricity works.

Albury (N.S.W.) Council will extend their generating electric plant at a cost of £32,000.

Wollongong (N.S.W.) Council has decided to expend £8,000 on electric supply and distributor cables. It is proposed to obtain electricity in bulk from the Government power house at Port Kembla.

West Maitland (N.S.W.) Council recently accepted an offer of the Caledonian Company to supply electricity in bulk, and about £20,000 will be spent on a distributing station and supply cables.

As the result of the recent deputation from the District Progress Association Bright (Victoria) Council will obtain a report from Mr. W. T. Bridger on the possibilities of lighting the town electrically.

The Government of Jamaica have arranged to obtain the services of two electrical engineers from England in connection with the proposal for the electrification of the railway, and for the utilisation of the water power of the Island.

The Victorian Minister of Mines announces that the Victorian Electricity Commissioners have collected particulars of methods employed in Germany for working brown coal and for the manufacture of briquettes. The brown coal existing in Germany is very similiar to the deposits at Morwell, which are said to afford the best basis of the extensive scheme of electric supply undertaken by the Electricity Commissioners of Victoria. The experience gained in working the deposits in Germany is expected to be particularly helpful in designing the Victorian plant.

☛ A company, with a capital of £1,000,000, has been formed in Santiago, Chili, for the erection of an electric power station of 30,000 h.p. for the supply of electric power to local industries and railways.

The Formosan Hydro-Electric Company has been formed for utilising the water power available at Lake Candidius and other parts of South Formosa and for the supply of cheap electric power in order to develop the agricultural, sugar and other industries.

It is proposed to construct an underground electric railway in Tokio, and the "Tokio City Company" has been formed with a capital of 50,000,000 yen (about £5,000,000) for the purpose. The length of the first section of the line will be 9 miles, and the period for completing it is three years.

The Swedish Government has authorised the municipality of Vaxholm, near Stockholm, to raise a loan of 100,000 Kr. to take over and extend the local electric supply undertaking. At the next session of the Riksdag a grant of 23,000,000 kroner will be voted for the completion of the water-power stations Alokarlei, Motala and Harspranget.

Telegraph and Telephone Notes.

According to an Admiralty notice it is shortly intended to send out gale warnings by wireless telegraphy to all ships at sea.

The Telegraphic Route via Marconi to the United States of America and Newfoundland has been temporarily suspended, due to a matter affecting an agreement with the Western Union Cable Company.

The Uruguayan Council of Administration has recommended the Legislative Chambers to authorise the Department of Wireless Telegraphy to contract for a loan of $200,000 (Uruguayan gold) from the Bank of the Republic, in order to carry out improvements and extensions in the radiographic services.

Owing to the recent storm telegraphic communication with the Continent and with certain parts of the North and with Ireland have been interrupted. This illustrates the need for more underground cables, and we hope that the Post Office authorities will proceed with the work of extending their underground network as rapidly as possible.

Arrangements are being made to establish a central wireless station under the Air Ministry for the collection of intelligence as to the movements of travelling aircraft and the meteorology of the upper air. The main exchange is at present in the offices of the Air Ministry at India House, Kingsway, but the new station will probably be near Croydon. A network of similar stations is to be extended throughout the country. The Marconi "continuous wave" system is employed.

A special wireless service between England and Italy, for the use of the newspaper Press, was opened on the 6th inst. by the Marconi Company. The service, authorised by the Italian Government and the British Post Office, was instituted particularly to assist the Italian Press in obtaining prompt reports of the Italian Prime Minister's visit to London. The Marconi high-powered station at Carnarvon is being used, and three hours daily have been allotted for this particular traffic.

The Radio Corporation of America, with a capital of $20,000,000 (£4,000,000), has been incorporated by the General Electric Company interests to take over the Marconi Wireless Telegraph Company of America, including the interest in that company acquired from the late British owners. The commercial wireless service is to cover both the Americas, Hawaii, Great Britain, France, Scandinavian countries, China and Japan, but the date of inauguration awaits the release of the wireless stations by the Government.

Institution Notes.

The next general meeting of the Wireless Society of London will be held on January 29 at 6 p.m. at the Institution of Civil Engineers, when a lecture illustrated by experiments and lantern slides will be given by Mr. R. C. Clinker, entitled "A Portable Valve Set and Some Properties of C. W. Circuits." It is announced that several provincial Wireless Clubs and Societies desire to become affiliated to the Society.

The annual dinner of the Liverpool Engineering Society will be held at the Exchange Station Hotel, Liverpool, at 7 p.m. on Thursday, Feb. 12.

Prof. W. H. Bragg, F.R.S., has recently delivered a course of six lectures adapted to a juvenile auditory at the Royal Institution. The subject was Sound, the lecturer giving first a general idea of the phenomena of sound. In this connection the "ripple tank" proved, he said, to be a useful device, and by its means the reflection of waves was very clearly shown. Sound shadows were demonstrated by a bird call and a sensitive flame, the particular flame used being very sensitive. The second lecture was concerned with music, and modes of vibration were illustrated by the vibrations of different lengths of spiral spring, which were controlled by the current flowing through the shortest length, the latter acting as a contact maker. The subject of the third lecture was "Sounds of the Country." The vibrations of bells were effectively shown by the spray resulting when a glass containing water was bowed. By means of a bird call, a sensitive flame and arcs of cardboard, the phenomenon of the whispering gallery was explained. In the fourth and fifth lectures Prof. Bragg dealt with sounds in the country and the sea. The way in which animals, such as the grass-hopper, chirp was explained; also the whistling of wind across wires and ropes was illustrated by the oscillating flow of water in passing an obstacle. In the concluding lecture Prof. Bragg described the utilisation of sound in war. A tank of water containing three floats actuating contacts in circuits controlling three pencils served very effectively to explain "sound ranging." The pencils each made a trace on a moving slip of paper, and was momentarily raised as the wave went past its corresponding float. The audience was also much interested in gramophone records of under-water sounds from submarines.

One of the special ailments of miners is nystagmus (or eye disease) which is mainly caused by deficient illumination. For some years there has been an agitation for better lighting and for the introduction of electric miners' lamps which are more extensively used in America. Miners' nystagmus, with special reference to its serious economic effects, was the subject of a paper read by Dr. T. Lister Llewelyn before the North Staffordshire Institute of Mining Engineers on Monday. After describing the symptoms of the disease, Dr. Llewelyn estimated that if a man were off work for a year the loss to the country would be at least £359 – made up of £65 compensation and £294 loss of coal output (235 tons at 25s. a ton, pithead price). Since 1913 there had been at least 6,000 men disabled each year from nystagmus, and the total direct cost to the country would be over a million pounds a year. He believed many small accidents, and probably some severe accidents, were the direct result of the disease; and there was always the possibility that a catastrophe might result from the failure of a fireman or collier suffering from the disease to detect the presence of gas. Deficiency of illumination was the dominating factor in the causation of the disease, and, in his opinion, was so important that all other factors became insignificant. One of his conclusions was that the illumination in safety-light pits must be increased at least fivefold, and he urged research work to discover a better illuminant for safety-light mines, suggesting that the Mining Association of Great Britain and the Miners' Federation should each subscribe £50,000 to a research fund.

The first meeting of the new session of the Birmingham and District Electric Club was held on the 10th inst., when a large number of members met to hear the new president (Mr. W. H. Wolton, A.M.I.E.E., A.M.I.M.E.) deliver his inaugural address. Mr. Wolton impressed upon the meeting that the moral damage and material losses caused by the war, and the widespread unrest among workmen, only meant that there was great work to do in solving the many problems thus forced upon us. He felt that the moral forces which had stabilised the nation during the war would stand us in good stead during the trying time of reconstruction. He pleaded for a liberal treatment of workers, not only during employment but during unemployment and incapacity, and for a full and enlightened reception by employers of the new Education Act. Mr. Wolton also claimed that the new Electricity (Supply) Act carried with it enormous possibilities for the electrical trade and profession. The new and larger central stations, with the greater and more universal supply of cheaper energy, together with the probabilities of the electrification of large sections of our railways, all meant great opportunities for the industry. At the close of the address Mr. Wolton spoke enthusiastically of the work of the Birmingham and District Electric Club, but he thought that the time had arrived when the great engineering district of the Midlands should have an important "Engineers' Club," which would form a meeting place for engineers, Civil, Mechanical and Electrical.

A good discussion followed, and Mr. R. A. Chattock, who proposed the vote of thanks in an interesting and informing speech, said his experience with the Industrial Councils in the electrical supply business gave him great hopes that these councils would in time go a long way to solve labour difficulties. Work in connection with the reorganisation of the supply of electricity on the lines of the new Act was already proceeding, and in a short time the evidence of progress would be seen.

Miscellaneous.

Decisions of the Industrial Court have awarded a 5s. increase per week from Dec. 1, 1919, to electrical workers on the London railways and to workers in electric generating stations and supply undertakings in the London area.

A cheque for £94 8s. 5d., being the balance of the funds of No. 3 Company, Royal Engineers (V.), London Army Troops Companies (Engineering Institutions Company), has been forwarded to Sir John Snell for distribution to the benevolent funds of the three engineering institutions, in accordance with the arrangement made when subscriptions were invited.

On the 10th inst. about 200 employees of Messrs. J. H. Tucker & Company attended the annual fancy dress ball which was held in the works canteen, and was promoted by the firm's social club. Mrs. J. B. Tucker distributed prizes for the best costumes, and in the course of his speech Mr. J. B. Tucker said that he was amazed at the rapid progress of the social club. A vote of thanks was passed to the social section committee, whose work had helped to make the function such a success.

Among the many after-the-war problems there is danger of one of the most self-sacrificing sections of ex-service men being overlooked. It is, of course, right that suitable positions should be found for the demobilised; but, of all the people who have suffered financially through the war, none has been hit so hard as the tradesman or professional man who had to give up his business or practice, or in some cases leave it in the hands of incapable understudies, while he went to serve. The Ex-Service Professional and Commercial Association, which has just been formed, is attempting to solve this problem, as it will provide the means of distinguishing the fact that they served by issuing an authorised sign, to be known as "The Sign of the Tin Hat." This sign will be affixed by members to their shop windows or brass plates, and be printed on their note-paper. The head offices of the association are at 38-39, Piccadilly, London, W.

Imports. The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during November, 1919, and (*b*) the aggregate figures from Jan. 1 to Nov. 30, with increase or decrease compared with corresponding periods of 1918 :—

Electrical machinery, (*a*) £40,615 (increase £7,014), (*b*) £672,458 (increase £78,226); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £18,129 (increase £6,042), (*b*) £278,173 (increase £120,992); and electrical machinery unenumerated, (*a*) £22,486 (increase £1,002), (*b*) £394,285 (decrease £42,766); telegraph and telephone cables, submarine, (*a*) nil, (*b*) £38 (increase £38); other than submarine, (*a*) £778 (decrease £1,235), (*b*) £11,762 (increase £5,582): telegraph and telephone apparatus, (*a*) £11,796 (increase £10,622), (*b*) £238,890 (increase £198,369); other electrical wires and cables, rubber insulated, (*a*) £2,598 (increase £2,573), (*b*) £7,474 (increase £5,254); with other insulations, (*a*) £693 (decrease £1,214), (*b*) £15,664 (increase £9,658); carbons, (*a*) £434 (decrease £2,358), (*b*) £26,633 (decrease £4,175); glow lamps, (*a*) nil (decrease £25,883), (*b*) £213,673 (increase £23,912); arc lamps and electric searchlights, (*a*) nil, (*b*) £31 (increase £31); parts of arc lamps and searchlights (other than carbons), (*a*) £1,265 (decrease £9,680), (*b*) £47,403 (decrease £28,827); primary and secondary batteries, (*a*) £1,481 (decrease £7,265), (*b*) £41,230 (decrease £89,043); meters and measuring instruments, (*a*) £3,561 (decrease £292), (*b*) £36,516 (increase £12,892); switchboards, (*a*) £92 (decrease £62), (*b*) £1,266 (decrease £1,644); electrical goods and apparatus unenumerated, (*a*) £27,061 (decrease £5,953), (*b*) £402,759 (increase £56,414). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £49,759 (decrease £40,747), (*b*) £1,063,339 (increase £73,633).

Exports.—The exports of electrical machinery, material, &c., (*a*) during November, 1919, and (*b*) from Jan. 1 to Nov. 30, with increase or decrease compared with corresponding periods of 1918 were as follows :—

Electrical machinery, (*a*) £197,233 (increase £112,535), (*b*) £1,618,572 (increase £651,634); including railway and tramway motors, (*a*) £11,652 (increase £8,696), (*b*) £85,324 (increase £47,694); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £109,259 (increase £65,771), (*b*) £933,680 (increase £347,363); and electrical machinery unenumerated, (*a*) £76,322 (increase £38,048, (*b*) £599,568 (increase £255,977; telegraph and telephone cables, submarine (*a*) £50,399 (increase £25,461); (*b*) £544,382 (increase £72,328); other than submarine, (*a*) £83,031 (increase £59,716), (*b*) £463,430 (increase £159,066); telegraph and telephone apparatus, (*a*) £53,942 (increase £38,456), (*b*) £371,703 (increase £191,791); other electrical wires and cables, rubber insulated, (*a*) £95,201 (increase £86,886), (*b*) £730,571 (increase £661,670); with other insulation, (*a*) £145,780 (increase £139,254), (*b*) £940,635 (increase £834,984); carbons, (*a*) £2,765 (increase £2,213), (*b*) £12,198 (increase £4,658); glow lamps, (*a*) £12,745 (increase £6,620), (*b*) £139,800 (increase £67,538); arc almps and searchlights, (*a*) £451 (increase £292), (*b*) £7,479 (decrease £10,012); parts of arc lamps and searchlights (other than carbons), (*a*) £1,044 (increase £1,044), (*b*) £9,894 (decrease £3,909); primary and secondary batteries, (*a*) £53,210 (increase £46,765), (*b*) £407,305 (increase £296,928); meters and measuring instruments, (*a*) £18,656 (increase £2,041), (*b*) £217,583 (increase £100,225); transformers, (*a*) £24,840 (increase £24,150, (*b*) £91,034 (increase £61,706); switchboards, (*a*) £2,907 (increase £768), (*b*) £43,552 (increase £8,532); electrical goods and apparatus unenumerated, (*a*) £163,831 (increase £130,823), (*b*) £1,187,714 (increase £813,672). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £708,802 (increase £564,489), (*b*) £5,167,280 ncrease £3,259,177).

Tenders Invited and Accepted.

Irvine Corporation require tenders by Jan. 19 for electric light wiring in 54 dwelling houses. Specifications from the Town Clerk.

Coventry Tramways Committee require tenders (by Jan. 20) for supply of 1,000 tons of steel tram rails. Specifications from the General Manager.

Bradford Corporation want tenders by Jan. 28 for supply of two electric battery locomotives. Particulars from Mr. J. Garfield, Esholt Hall, Shipley.

Aberdeen Electrical Committee require tenders for two water-tube boilers, superheaters, economisers, &c. Specifications from the City Electrical Engineer, Mr. J. Alex. Bell, and tenders by noon Jan. 31.

The Victorian Government Railway Commissioners require tenders by Feb. 26 for incandescent electric lamps (contract 32,894). Forms of tender from the Secretary, Railway Offices, Melbourne.

Battersea (London) Council require tenders by noon Jan. 21 for 5,000 kw. turbo-alternator, &c., 1,500 kw. rotary converter, switchgear, &c. Specifications from the Borough Electrical Engineer.

Islington (London) Council require tenders by noon Jan. 28 for one year's supply of stores for their electricity department, including cables, meters, lamps, &c. Specifications can be obtained at the Town Hall.

Pontypridd Urban Council invite tenders for the supply and erection of a rotary converter, transformer and switchgear. Specifications from the engineer, Mr. J. E. Teasdel, and tenders to the clerk, Mr. H. Leonard Porcher, Municipal-buildings, Pontypridd, by noon Jan. 30.

Dundee Corporation invite tenders for supply and erection of three 750 kw. and one 300 kw sets of rotary converting machinery, and one 12-panel, 11,000 volts e.h.t. switchboard, and three D.C. machine control panels. Specifications from the General Manager and Engineer. Tenders must be lodged with the Town Clerk by Jan. 23.

The Electricity Committee of Hull Corporation invite tenders for the supply and erection of a 10,000-kw. turbo-alternator with exciter and one condenser outfit. Forms of tender from the City Treasurer, Mr. T. G. Milner, and tenders, addressed to the Chairman of the Electricity Committee, Guildhall, Hull, must be in by Jan. 23.

Hammersmith (London) Borough Council invite tenders for material required for boiler setting and furnace work, or supplying materials and executing the work, or for executing the work only. Specifications from Mr. G. G. Bell, 88, Fulham Palace-road, W.6, and tenders to the town clerk, Mr. Leslie Gordon, Town Hall, Hammersmith, W.6, by Jan. 20.

Hammersmith (London) Council also desire to be furnished with particulars of wiring systems which contractors are prepared to submit suitable for property to be erected in connection with the Council s housing scheme. Particulars from the Borough Electrical Engineer and propositions to the Town Clerk by Jan. 20.

Stepney (London) Electricity Committee invite tenders by Jan. 22 for manufacture and erection of two water-tube boilers, economisers and other accessories, and one 5,000-kw. turbo-alternator condenser, &c

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Stepney (London) Borough Council has accepted the tender of Messrs. Bruce Peebles & Company for the supply of two new converters for the Mile End sub-station at £5,400 each. The quotation of Messrs. Sutton & Company for troughs, covers, and earthenware pipes at £253 16s. 11d. has also been accepted.

Personal and Appointments.

Lieut.-Col. B. C. Battye, D.S.O., R.E., has been placed in charge of the temporary Public Works Division, which has recently, been constituted with headquarters at Lahore, and is known as the Sutlej River Hydro-Electric Project Division.

Liverpool Corporation have accepted with regret the resignation of Mr. C. W. Mallins, the tramways manager, after 22 years municipal service. A resolution was passed in appreciation of the work of Mr. Mallins on behalf of the Corporation.

Mr. James Wild, manager of Ramsbottom Tramways, has been appointed manager of Todmorden Corporation motor omnibus department at £300 per annum.

The Accrington electrical engineer has been authorised to engage Mr. G. Kirk to undertake the duties of draughtsman and meter tester for 12 months at £250 per annum.

Mr. James Brierley, traffic superintendent of the Rhondda tramways, who has resigned in order to take up a similar position under the Southampton Corporation, has been presented with a cheque by his colleagues as a mark of esteem. Mr. G. B. Horner, of Wigan, succeeds Mr. Brierley.

Appointments Vacant.

A shift engineer is required by the Accrington electric supply department. Salary £264 per year, inclusive of 20 per cent. and £90 bonus. Applications to the Borough Electrical Engineer.

A lecturer in electrical engineering is required at the University of Bristol. Salary £350–£10–400. Particulars from the Registrar of the Merchant Venturers' Technical College, Bristol.

An assistant lecturer and demonstrator in electrical engineering is required at the University of Sheffield. Salary £300. Applications to the Dean of the Faculty of Engineering by Jan. 24.

The Municipal Commissioners of Singapore require an assistant electrical engineer. Salary $3,600 per annum, with annual increments of $270 plus duty allowance of $720 per annum. Applications to Messrs. C. C. Lindsay & Peirce, 180, Hope-street, Glasgow, by Jan. 27.

Business Items, &c.

Samuel Thos. Pemberton and Ernest Marples (trading as S. T. Pemberton & Company), electrical engineers, 8, Church-street, Birmingham, have dissolved partnership. Debts by Mr. Pemberton.

The partnership between Jas. Copland, Wm. A. McGuire and Thos. Murphy (trading as the Armature Repair Company), 5, Hirst-street, Liverpool, has been dissolved as regards Thos. Murphy. Debts by Messrs. Copland & McGuire, who continue the business.

Mr. Edwin Jacob has resigned his position as Managing Director of the Tudor Accumulator Company as from the 31st ult. The London office of the company will, in future, be conducted under the management of Mr. A. C. Soutter, who has been in the service of the company for the past 22 years, and the works at Dukinfield will continue under the management of Mr. Paul Pescatore, with the same staff as hitherto.

Mr. M. D. Jones, who has had many years experience in the design and erection of Fuller-Lehigh cement plants, pulverised coal installations and mills, and who has specialised in the application of pulverised fuel to all kinds of furnaces in the iron and steel industries, will be attached to the London office of the Fuller Engineering Company, as from January, 1920. Mr. Ernest E. Noble, late of the Stirling Boiler Company, has joined the Fuller Engineering Company, and will give his special attention to the application of pulverised coal to boiler plants and locomotives. Mr. H. W. Portas, late Superintendent Engineer for the Ministry of Munitions, machine tool section (aero engine production), who has had a wide experience abroad in the erection and operation of mining plants, will handle all matters connected with plant equipment. The Fuller Engineering Company, 25, Victoria-street, London, S.W.1, will therefore have expert advice and the assistance of experienced engineers available on all matters connected with pulverising equipments, cement plants and pulverised coal applications.

Catalogues, Price Lists, &c.

Messrs. E. P. Allam & Company send us a useful desk calendar, consisting of adjustable monthly sheets in a neat frame.

Messrs. A. P. Lunberg & Sons have recently issued the second edition of "A First Course of Electric Light Switching and Testing."

We have received from the Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., a number of pamphlets and leaflets dealing with the company's industrial power and railway apparatus, &c.

Among the trade literature recently issued by Messrs. C. A. Vandervell & Company are Folder C, which gives particulars and prices of the C.A.V. range of accumulators for car lighting; and Folder D, relating to C.A.V. replacement batteries and ignition accumulators for American automobiles.

Messrs. Matthews & Yates, Ltd., of Swinton, have issued a booklet relating to their "Cyclone" d.c. motors. Besides giving particulars as to their manufacture, adaptability, &c., the list gives the h.p. required for a good range of machines in different industries, and should prove of direct interest to those interested in the electric drive or to those requiring additional power.

Messrs. Matthews & Yates, Ltd., Swinton, Manchester, have also issued some leaflets giving particulars and prices of some of their other manufactures. Leaflet No. 103/1 supersedes list No. 103, and covers a range of the "Cyclone" steel plate electric blowers and exhausters. The new list covers blowers giving pressures of ¾ in., 1 in., 1½ in., 2 in., 2½ in. and 3 in. water gauge, with full data as to outputs, &c., on the different pressures. Leaflet No. 128 deals with the "Cyclone" electric vacuum cleaner; and leaflet No. 2/1 relates to a range of "Cyclone" belt-driven air propellers from 18 in. to 72 in. diameter, full data regarding same being given.

Good illumination keeps down street accidents and assists the police in maintaining order. There is therefore a general demand for improved public lighting, and with this object many supply authorities are considering the question of extending the electric lighting of the streets. The issue of Messrs. Johnson & Phillips' arc lamp catalogue and of a folder showing the cost of running their Metropolitan Magazine flame arc lamp is therefore opportune. The catalogue gives illustrated descriptions and prices of the "Metroflam" flame and the "Orb" shuntless single enclosed arc lamps, with a summary of their advantages, and also prices of carbons, line resistances, arc lamp pillars, raising and lower gear, &c. The folder gives figures of the comparative running costs of a 2,000 c.p. street lighting unit per year of 4,000 lighting hours, the comparison being between an 8 ampere Metroflam lamp and two half-watt 1,000 c.p. tungsten lamps.

Liquidations and Bankruptcies.

A meeting of creditors of the Holme Electric Company, Ltd. (in vol. liq.) will be held on Jan. 19 at 1, Westgate, Huddersfield.

A meeting will be held on Feb. 23 at Suffolk Chambers, Lowestoft, to receive an account of the winding up of the Oulton Broad Electricity Company, Ltd.

The New St. Helen's & District Tramways Company, Ltd., is being wound up voluntarily, and Mr. H. P. Conibear and Mr. E. H. Edwardes have been appointed liquidators. A meeting of creditors will be held at 5, Fenwick-street, Liverpool, on Jan. 16.

Claims against Cecil Hellyer (trading as A. Parker & Company), electrical engineer and contractor, 130, Upper Richmond-road, East Sheen, Surrey, are to be sent by Jan. 26 to Mr. Thos. Gourlay, 132, York-road, S.E.1.

Companies' Reports, &c.

The directors of the Anglo-Argentine Tramways Company, Ltd. announce that the Buenos Aires municipality has sanctioned an ordnance approving an increase in fares.

The Marconi International Marine Communication Company, Ltd., have declared an interim dividend of 5 per cent. for 1919, being 1s. per share less tax.

The interest on the Eastern Extension Australasia & China Company's 4 per cent. mortgage debenture stock for the half-year ending Jan. 31, due on the 1st prox., will be paid by warrant on Feb. 2 next. The stock register will be closed from the 27th to the 31st inst. inclusive.

A conditional agreement has been entered into between the Vulcan Boiler & General Insurance Company and the London Assurance Company, under which the latter offers to acquire from the shareholders of the Vulcan Company their shares on certain terms.

The directors of the Castner-Kellner Alkali Company, Ltd., have received an offer from Messrs. Brunner, Mond & Company to purchase not less than 75 per cent. of the shares of the company not now owned by them by the issue of two fully-paid Brunner-Mond ordinary shares for one fully-paid ordinary share of the Castner-Kellner Company.

The directors of the Anglo-American Telegraph Company, Ltd., announce balance dividends of £1 10s. per cent. upon the ordinary consolidated and preferred stocks, and a first and final dividend of £1 10s. per cent. upon the deferred stock, making, with these already paid, £3 15s. per cent. upon the ordinary consolidated stock, £6 per cent. on the preferred stock and £1 10s. per cent. on deferred stock for the year 1919.

The British Glass Industries, Ltd., has acquired the entire share capital of the following companies: Cannington, Shaw & Company, Nuttall & Company, Robert Candlish & Son, Alfred Alexander & Company, Aire & Calder Glass Bottle Works (E. Breffit & Company), and Moore, Nettlefold Company. A large modern glassworks is being erected at Charlton, Kent, by United Glass Bottle Manufacturers, Ltd., in which the British Company has acquired a controlling interest.

The directors of the Dublin United Tramways Company, Ltd., have decided to make following allocations: To track renewals, £30,000; to car renewals, £27,000; to general reserve, £12,321 (bringing this fund up to £100,000); to write off for depreciation in investments £4,000; and to pay following dividends (less tax) for the half-year ended Dec. 31, 1919: 6 per cent. on the preference and 7 per cent. on the ordinary shares (making, with interim dividend paid in August, 6 per cent. per annum), and bonus of 1s. 6d. (tax free) on each £10 unit of ordinary stock, carrying forward £17,080.

Mr. J. Braithwaite, who presided over the annual meeting of the Adelaide Electric Supply Company, Ltd., last week, said that the results of the past year had been disastrously interfered with by the prolonged strike which had taken place in Australia, and had only ended just about the close of their financial year. By that strike they had lost 2¼ millions of units, and their profit, instead of being a record as they had hoped it would be, was quite normal. As it was, the revenue had increased by £18,993. The number of consumers had increased by 3,132, compared with 2,327 in the previous year. In spite of the strike, not only had their gross revenue increased a little, but their units had also increased to a small extent. The extensions to mains during the year had increased by 22 miles of streets, and they were now supplying 500 miles. They were actively engaged on the laying out of the new power house at Port Osborne.

In the course of his speech to the shareholders of the Anglo-Dutch Plantations of Java, Ltd., at the recent annual meeting the Hon. C. H. Strutt stated that their electric power station had a maximum capacity of 2,000 kw., but they had not, however, up to date used anything like that power. They were to be allowed to use sufficient water to obtain their maximum, provided they did not interfere with the water requirements of the population for agricultural purposes, &c., and they were to be permitted to use overhead wires for the transmission of power free of charge over the roads taken over by the Government. They had also been granted the exclusive right for 25 years to build another power station in Segalaherang, where there was a large waterfall, subject to any regulations to be brought into force later by the Government, and not to the detriment of the native population.

An interesting sketch of the development of the British Mannesmann Tube Company, Ltd., and of its war work, was given by the chairman (Mr. R. S. Guinness) at the annual meeting last week. After payment of a dividend of 8 per cent. and a bonus of 1 per cent., for the year the carry forward amounted to £72,769. The manufacturing profit (£150,144) was derived from the operation of the Landore works alone. The Newport works, being still in process of construction, had not contributed to the earnings, while there had been debited to manufacturing costs the inevitable expenses at Newport of maintaining and training a staff and producing a restricted output. In addition to developing their organisation for home business, they had extended their tentacles abroad. They had cemented their connections in New Zealand and had appointed agents in India, Australia, South Africa, Borneo and the Far East, in Spain, Portugal, Switzerland, the Pacific coast of South America and the Argentine. They found their tubes and pipes in houses for electric light, water and gas, and for many other purposes, including cylinders for aeroplane work, high-pressure main and pit props in mines.

At a subsequent extraordinary meeting it was decided to increase the capital to £2,000,000 in ordinary shares of £1 each.

New Companies.

CASCOLL ENGINEERING COMPANY, LTD. (162,046).—Private company. Reg. Dec. 23, capital £1,000 in £1 shares. Objects: To carry on the business of mechanical, chemical and electrical engineers, manufacturers of and dealers in motor cars and vehicles, &c. First directors are C. F. Casperson and R. Collins. Secretary: C. F. Casperson. Reg. office: 20, Garden-street, Marsh-lane, Leeds.

W. CROOKELL & COMPANY, LTD. (162,199).—Private company. Reg. Dec. 30, capital £1,500 in £1 shares. Objects: to take over the business of an electrical engineer carried on by W. Crookell at Middleton, Lancs., as W. Crookell & Company. W. Crookell is first director. Secretary: W. Proctor. Reg. office: Water Street Works, Middleton.

DEANS ELECTRICAL & ENGINEERING COMPANY, LTD. (162,269).—Private company. Reg. Dec. 31, capital £1,000 in £1 shares, to carry on the business indicated by the title. First directors are H. J. Dean, 19, Leedham-road, Sheffield, and R. Lavie, York. Solicitor: W. Ramsden, Station Street-buildings, Huddersfield.

ELECTRICAL MAINTENANCE COMPANY (LIVERPOOL), LTD. (162,072).—Private company. Reg. Dec. 24, capital £2,000 in £1 shares. Objects: to take over the business carried on by H. V. Greenep, at Liverpool, as the Electrical Maintenance Company. First directors are H. V. Greenep, E. Durden, H. Copland, H. Curphey and C. G. Curphey. Reg. office: 142a, London-road, Liverpool.

HEATH PLUGS, LTD. (161,947)—Private company. Reg. Dec. 22, capital £12,000 in £1 shares, to acquire from A. E. Heath a sole licence to use certain patents relating to sparking plugs, to acquire the assets of Heath, Norton & Co., &c. First directors are A. E. Heath, H. Norton, H. H Hassall, E. E. Glover and F. E. Preston. Reg. office: 2, Sancroft-street, London, S.E.11.

HOLDERS, LIMITED (10,863)—Private company. Reg. Dec. 30 capital £10,000 in £1 shares, to carry on the business of electrical, mechanical and general engineers, contractors, &c. Secretary: R. Mitchell. Reg. office: 87, Hanover-street, Edinburgh.

INTER-CONTINENTAL ENGINEERING COMPANY, LTD. (161,768).—Private company. Reg. Dec. 17, capital £103,500 in 100,000 preference shares of £1 each and 70,000 ordinary shares of 1s. each. Objects: to carry on the business of importers, exporters, mechanical, electrical and engineers, &c. First directors: Col. Sir E. W. D. Ward, Bart., G.B.E., K.C.B., K.C.V.O. (chairman), Earl Fitzwilliam, K.C.V.O., C.B.E., D.S.O., Capt. E. S. Ward, H. H. Powell, A. Hutchings, O.B.E., J. A. Smith (Syracuse, N.Y.), and J. N. Wyllis (New York City). Reg. office: 20, Conduit-street, W. 1.

H. F. STEPHEN, LTD. (10,847).—Private company, Reg. in Edinburgh, Dec. 26, capital £10,000 in £1 shares, to carry on the business of electricians, electric light and power and general engineers, &c. First directors are J. Mitchell, R. L. Mitchell, J. Mitchell, jun., H. F. Stephen and F. W. Stephen. Solicitor, C. G. Masson, 21, Broad-street, Peterhead.

SUTTON-IN-ASHFIELD MOTOR & ELECTRICALENGINEERING COMPANY, LTD. (161,841).—Private company. Reg. Dec. 18, capital £20,000 in 19,950 preferred ordinary shares of £1 each and 1,000 deferred ordinary shares of 1s. each, to carry on the business indicated by the title, and to adopt an agreement with R. Fenna. First directors are: J. B. Hole and B. Walton, jun. (both permanent). Reg. office: Bank-chambers, Sutton-in-Ashfield.

Prices of Metals, Chemicals, &c.

Tuesday, Jan. 13.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£125 0 0	—	£1 0 0
Electro Wirebars...	,,	£126 0 0	—	£2 0 0
H.C. wire basis......	per lb.	1s. 4⅞d.	—	¼d.
Sheet	,,	1s. 5⅞d.	—	⅛d.
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8⅝d.	—	¼d.
Brass 60/40—				
Rod, basis	,,	1s. 0¾d.	¾d.	—
Sheet, basis	,,	1s. 3⅜d.	¼d.	—
Wire, basis	,,	1s. 3½d.	¼d.	—
Iron—				
Cleveland Warrants	per ton	£9 2 6	£0 18 6	—
Galvanised steel wire, basis 8 SWG	,,	£35 10 0	£1 0 0	—
Lead Pig—				
English	,,	49 0 0	£0 10 0	—
Foreign or colonial	,,	47 10 0	—	—
Tin—Ingot	,,	378 5 0	£12 15 0	—
Wire, basis	per lb.	0 4 8	3d.	—

Salammoniac.—Per cwt. 95s. and 90s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £40.

Boric Acid (Crystals).—Per ton £72.

Carbon Bisulphide.—Per ton £56.

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—T.N. Orange, 880s.

Rubber.—Para fine, 2s. 7½d.; plantation 1st. latex 2s. 8¼d. lb.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd, and the rubber figures by W. T. Henley's Telegraph Works, Company

Thirty-Seven Years Ago.

[From The Electrician, Jan. 13, 1883.]

Electric Lighting at the Mint.—The Royal Mint, which has just been entirely reconstructed, will be lighted by electric light, and telephones will be largely used throughout the building.

West India & Panama Telegraph Company.—The estimated traffic receipts of this company for the half-month ended December 31 are £2,080, as compared with £2,405 in the corresponding period of 1881.

Eastern Extension Telegraph Company.—The traffic receipts of this company for the month of December, 1882, amounted to £31,617, and to £31,319 for the corresponding period of 1881, being an increase of £298.

London Platino Telegraph Company.—The revenue of this company for the month of October is estimated at £2,112 (Western Brazilian portion £1,546, land lines £566), as against £1,856 for the corresponding period of 1881.

Society of Telegraph Engineers and of Electricians.—At the meeting of the society, to be held on Thursday, the 18th inst., at 8 p.m., Mr. Willoughby Smith will deliver his inaugural address, as president, for the ensuing year.

Electric Light in Berlin.—The Berlin correspondent of a daily paper says that during the festivities at the Old Castle (belonging to the Imperial Family) this season all the rooms are to be illuminated with electric light. The work of preparation has already begun.

The Charing Cross Electric Railway.—The inhabitants of part of the district through which it is proposed that this railway and its extensions shall pass have resolved to oppose the scheme. They have called on the Lord Mayor to summon a meeting of the citizens at an early date to consider the matter.

Electric Lighting in Dublin.—At a meeting of the Lighting Committee of the Dublin Corporation, held last week, the question of electric lighting was discussed, and it was unanimously resolved to engage the services of Mr. Angelo Fahie, C.E., of Dublin, as consulting electrician to advise the Committee on the subject.

Electric and Gas Lighting at Sheffield.—At a meeting of the Electric Lighting Committee of the Sheffield Town Council, held last week, a report was read from Mr. Conrad Cooke, electrical engineer retained by the Corporation to advise as to applying to the Board of Trade for a provisional order under the Electric Lighting Act, in which he recommended that the streets of the town should not be lighted by electricity, but by gas.

To be Wound Up.—At a meeting of the Dublin Electric Light Company on Thursday week it was decided that the company should be voluntarily wound up, and an endeavour made to sell the company's plant and connection as a going concern. The company was formed in June, 1881, with a capital of £150,000 in £10 shares, of which 4,070 shares were taken up. A sum of £4 per share was called up, making a total of £16,280 subscribed. Mr. Gardner, of Messrs. Gardner, Craig & Company, was appointed liquidator, and a committee of five shareholders requested to superintend the winding-up proceedings.

From the Leader (1882).—Last week we ended our review of the year with a reference to what the Post Office has done in the way of establishing telephone exchanges. This week we may therefore fitly take up the threads of our subject by referring to private telephonic enterprise. In our review of telephonic work for 1881 we said "the progress made by the telephone during the past year has been extraordinary, and we may look for even greater advances in 1882." This forecast, which we may remark was a very safe one, has been amply verified. The great event of the year has been what by common consent is called "The Telephone Case," though, in reality, several separate actions have been tried. . . . Practically, the United Telephone Company have, after much litigation, made themselves masters of the situation for the present, and with this we will take leave of the legal vicissitudes experienced by the telephone during 1882. . . . Another interesting achievement of the year was that accomplished by M. Van Rysselberghe, of the Brussels Meteorological Observatory, who succeeded in sending telegraphic and telephonic messages a considerable distance along the same line, with good results at the receiving station. . . . During the year, Captain M'Evoy has patented what has been called "a submarine detector," in which the telephone plays an important part. It consists of a box containing two coils of wire, and a make-and-break contact and a telephone. From this leads a small cable containing four insulated wires, to which is attached another box containing two more coils. The four wires and the two sets of coils, &c., form two circuits, a primary and a secondary, the telephone being in the secondary circuit. A battery being connected to the primary circuit, the coils are adjusted until little or no noise from the make-and-break arrangement is heard on the telephone. The small box and cable is then let down into the sea or river, and on coming near to any metal body a loud noise will be heard in the telephone. . . . At present, overhead wires are the rule, and seem likely to continue so, if we may quote Mr. W. H. Preece's opinion, as given in his Paper before the British Association last year. He says: "The use of underground wires very seriously impedes telephonic extensions, and with our present apparatus and present knowledge we cannot readily speak over greater distances than 20 miles." . . . Last year we mentioned that "The Times" utilised this company's system to verbally transmit the speeches of members of the House of Commons to its office in Printing House-square. "The Times" found the telephone so useful that it now makes use of two wires in place of the one originally employed. The "Freeman's Journal" also has adopted the same means of communication between its offices in the Strand and the House of Commons.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,175. [No. 4. Vol. LXXXIV.] FRIDAY, JANUARY 23, 1920. PRICE SIXPENCE. By Post, 7d. Abroad, 9d.

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Notes.

The Synthetic Nitrogen Industry.

SOMETHING seems to be wrong with that part of the Government machine whose business it is to deal with the issue of official publications. One of the London police magistrates recently complained of the difficulty of obtaining copies of the Acts passed at the end of the Parliamentary session in December last, while we have only just been able, after repeated attempts, to secure copies of the authorised versions of the Electricity (Supply) Act and the new Patents Act. Even when the matter has been printed it is sometimes only freed for publication after considerable delay. A case in point is the report of the Nitrogen Products Committee, which has been in type for the past six months, but was only "released" a few days ago. Though it has certainly not lost in value by the delay, it has certainly not gained; and it would be interesting to know what has been the cost of keeping 350 pages of type standing for that period. On another page of this issue we devote considerable space to this report, which includes a survey of the pre-war conditions in the nitrogen industry, and a consideration of the power required for nitrogen fixation and of the economics of the established processes. An account of partly developed processes and of recent inventions are given, together with a description of the researches made thereon. The effect of the war on this industry and on its future policy is discussed, while the post-war aspects of the problem and the probable requirements and resources of the United Kingdom and the colonies are not forgotten. The report concludes with a number of important recommendations, such as the immediate establishment of the cyanamide industry on a scale sufficient to give an output of 60,000 tons per annum. To do this it is proposed that either the water-power available in Scotland should be developed, or that the necessary energy should be obtained from one of the new super-power steam turbine stations. It is also proposed that the Haber process of manufacturing ammonia synthetically should be employed in this country, so that an output of at least 10,000 tons of ammonia per annum can be reached as quickly as possible: and that the ammonia oxidation process should be employed on such a scale that 10,000 tons of strong nitric acid per annum can be obtained. In connection with the first of these recommendations, the recent proposal to erect large works in Cumberland to obtain synthetic ammonia by the Claude process is of interest. It will be remembered that this is a French process, and differs from the Haber process in that it aims at increasing, instead of diminishing, the pressure at which the nitrogen and hydrogen combine, the pressure employed being, in fact, of the order of 1,000 atmospheres. It is said that the first unit to be installed on this system will be able to provide about 50,000 tons of sulphate of ammonia per annum.

The Nitrogen Industry and Electrical Engineers.

To chemical engineers and electro-chemists the report cannot fail to be of the greatest interest, and it is superfluous to add that it will repay careful study. The production of nitrogen products is in every sense of the word a key industry. Before the war the world's requirements of this commodity were met almost entirely from the Chilean nitrate fields, and from the "by-product" ammonia of gas works and similar factories. Synthetic nitrogen as an industry was in its infancy. As regards the position of the United Kingdom more particularly, we produced "ammonia-nitrogen" in large quantities of which the greater proportion was exported in the form of ammonia sulphate, while we depended on exports for our heavy requirements of "nitrate-nitrogen" for the agricultural and explosive industries. The life of the Chilean fields must by the very nature of things be limited, while as regards ammonia the by-product has already become as important as the main product, and for that reason introduces complications which, apart from other considerations, limit the scope of this method. It is therefore essential that we should turn to other sources for our nitrogen requirements, and the various synthetic processes give us excellent methods of doing this. To adopt such methods will mean the further use of electric power on a large scale, and the section of the report in which the problems of the utilisation of electric power for this purpose are discussed will be the most interesting to electrical engineers. It is shown that at the present time the steam turbine station with coal-fired boilers is the most economical way of obtaining the necessary power: and that such a station with a maximum load of 100,000 kw., and a load factor of 97·5 per cent., would, with coal at 7s. 6d. per ton, show a generating cost of £3·75 per kilowatt, inclusive of depreciation and interest. These are, of course, pre-war figures. The energy consumption would amount to 1·87 kw.-years per metric ton of nitric acid of 100 per cent.

strength produced. It should be noted that while the efficiency of the arc process is low, so that about 90 per cent. of the energy is contained in the heat of the furnace gas, yet this heat can be usefully employed for steam raising. Direct firing is the most economical method of using coal, and becomes more economical as the price rises.

The Recommendations Must Be Acted Upon.

We hope that this report will escape consignment to some dusty pigeon-hole in a Government office. The results are most valuable, and should be immediately acted upon in order that an adequate supply of fertilisers and other nitrogen products may be obtained from atmospheric resources in the best possible way. Another argument in favour of this course is that it would render us independent of other countries. The Committee have made this course easier by the whole-hearted way in which they have done their work. Not only was evidence taken, but works were visited and processes tested, often in the dead of night. A laboratory was established and a number of valuable researches carried out. Their work is an example of the best kind of thoroughness, and they deserve the nation's thanks for their efforts. These thanks, we think Sir Henry Goold-Adams and his fellow Committeemen will agree, can best be expressed by adopting the recommendations and taking advantage of the results of the researches they have so laboriously performed.

The Eyesight of Miners.

In a recent address before the North Staffordshire Institute of Mining Engineers, Dr. L. Llewelyn gave some striking figures relating to miners' "nystagmus," a nervous disease of the eyes, which has been the subject of much study during recent years, and has given rise to much concern. It is estimated that quite £1,000,000 is lost to the nation annually through this disease, and this amount may have to be further increased if all the accidents due more or less directly to this form of defective eyesight are taken into account. The causes have been frequently discussed and are complex, but it now seems to be well established that nystagmus is due mainly to the peculiar conditions of light under which miners work, and is, in fact, primarily caused by insufficient illumination. Miners' lamps have been greatly improved, and prizes have been offered by the Home Office for the best types. Some of the electric hand-lamps now available are a striking advance over those employed in the past. "The Times," in commenting on the matter, remarks that, whatever views may be held on other debatable questions in the coal industry, the need for effective illumination to combat this disease cannot be questioned. We believe that, difficult as are the conditions in mines, the lighting might by systematic study be vastly improved, and that this improvement, besides helping to prevent such affections as "miners' nystagmus," might prove to have a very material influence on efficient production. Miners' lamps suggest themselves as the first subject for study, and a proposal is that these should be increased in candle-power and carried on the head. Dr. J. S. Haldane points out that this was done experimentally some years ago, but was given up owing to the regulations. We shall hope for the speedy reintroduction of this apparatus, as a lamp of this type is both safe and efficient.

The Works Power Station versus Public Supply.

An interesting discussion can always be inaugurated among electrical engineers on whether it is best for a manufacturer to erect his own generating station or to take a supply of electricity from the public mains. A discussion on this subject has the further advantage that, on its conclusion, both sides are equally sure that the victory rests with them. The reason for this is that no general solution of such a question is possible. There may be cases where it is more economical to install private generating plant, though we should think that the number of these must be rapidly decreasing. It is interesting to note, however, that just recently two further advocates of this particular method of generating electrical energy have come forward. In his annual memorandum to the Manchester Steam Users' Association, Mr. C. E. Stromeyer is very definite upon the point. He thinks that the replacement by many manufacturers of small high-pressure steam engines by electric motors supplied from the mains has been an absolute failure, and has only resulted in an increase in the coal bill. We cannot agree with this; for so sweeping a statement cannot be universally true. Again, Mr. Stromeyer thinks that manufacturers would obtain no advantage from the erection of super-power stations, because large stations are not so much more efficient than small; while the statement that they can use refuse coal he also considers a fallacy, as such coal has only 30 per cent. of the heating value of good quality coal. He also disposes of the statement that in the super-power station the load factor will be high, therefore giving an advantage to works taking supply, by pointing out that in works using their own generating plant there is no reason why the load factor should not be even higher than that of a public supply station. This statement, of course, presumes that the works will run 24 hours a day for 365 days in a year, which is not very usual.

Gas Engines and the Electric Drive.

The other advocate for individual driving is our contemporary the "Gas World," which, in two interesting articles in the current issue, deals with the application of gas and gas engines to biscuit baking and to laundries. In the former industry gas-heated ovens are now largely employed. These ovens are worked on what may be called the chain grate system, and are often driven by electric motors. Our contemporary advocates the use of gas engines for providing the necessary electricity supply in this case because gas is already used for heating the ovens. In the case of laundries much the same argument is advanced. At first sight it would appear that in a laundry a steam engine could be more efficiently employed than a gas engine; but it is pointed out that the high-pressure steam required for the engine is never an economical method of obtaining the low-pressure steam required in the various laundry operations; while at the beginning of the week, when a maximum amount of steam is required in the wash-house, a great deal of the other plant is idle, and the steam engine would, therefore, be lightly loaded.

The Gas Engine Only an Expedient.

Both these advocates, we are interested to see, have the unwilling conviction that the electric motor is the best method of driving machinery. Mr. Stromeyer's arguments on the disadvantages of bulk supply have been advanced many, many times, and have been exploded as often. Still, they are not without their value. Our contemporary is in much the same position, for with the advance in our knowledge of what can be done with electric heating, it is obvious that electricity will be increasingly used in laundries until gas and steam are finally excluded, not only for economical, but for hygienic, reasons. It is already largely used for ironing simply because there are no fumes. In the bakehouse it may be said an advance will take place along similar lines. Biscuit making is an operation which requires very close regulation of the heat employed, and for this purpose electric heating is obviously the most desirable method to use. When and where it appears we are afraid the knell of the gas engines will be sounded.

The Popularisation of Science.

The war has seen a revival of public interest in science, an interest which, if perhaps too exclusively centred on the direct benefits applied science brings in its train, is none the less gratifying. There is, however, some danger of a relapse now that the strain of war is over, and therefore any effort calculated to maintain this influence on the public mind is to be encouraged. It is necessary, first, to feed this enthusiasm for science, and, second, to render it more discriminating. An impression that quick and sure returns for investment in scientific research are certain is liable to lead to disappointment. People need to know more of the difficulties of scientific research as well as its triumphs. We are, therefore, glad to notice that the Royal Society, in conjunction with other scientific bodies, contemplates issuing this year a popular journal under the title of "Discovery," which aims at explaining in simple terms the chief features of scientific progress. Scientists have complained of the indifference of the public, but have, perhaps, not sufficiently realised that there is a reverse side to the picture. In the days of HUXLEY, TYNDALL and other eminent scientific lecturers of the last century, not only was science broader, less specialised and easier to grasp, but it had, we believe, more able popular expositors. Men of science of the present day need to step down from their pedestals, to depart from the attitude of aloofness which had been characteristic of recent scientific work—to show that science is not the perquisite of a privileged intellectual caste but a subject of human interest to the world at large.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

Dr. C. V. Drysdale contributes an article on "A Universal Inductance and Capacity Testing Bridge" (page 80). Measurements of inductance and capacity have become increasingly important in connection with cable and radio-telegraphy. Most of the methods used are on the "bridge" principle. He describes a simple bridge which has been designed to fulfil the necessary conditions, and gives a number of tests which can be carried out with it.

On page 82 we give an account of the final report of the Nitrogen Products Committee, which was appointed in 1916 to consider various questions in connection with this important subject. This report is likely to be of great interest to electro-chemists and electrical engineers.

On page 84 we describe the equipment which has been installed at Manchester and Salford to enable a bulk supply to be given to the latter town from the Manchester Electricity Supply Undertaking. The supply is at 33,000 volts on the three-phase system. The various details of the system are interesting and are fully illustrated.

On page 87 we conclude our account of the Paper on "Failures of Turbo-Generators," recently read before the Institution of Electrical Engineers by Mr. J. Shepherd.

On page 92 we continue our account of the exhibits at the recent Physical Society exhibition.

Our Leading Article (p. 95) deals with certain legislative modifications in the law governing electricity supply which are caused by the passing of the Electricity (Supply) Act. A full abstract of the Act as officially received from the Government printers is given on page 96.

On page 88 we give our usual article dealing with the progress that has been made in electric heating and cooking.

Some particulars of an important scheme for the conversion of three French railways to electric traction are given on page 98.

Some recent Papers of electrochemical interest are dealt with on page 97.

We publish an appeal for £100,000 in order that a much-needed extension may be made to the engineering laboratories at University College, London (page 102).

Arrangements for the Week.

FRIDAY, Jan. 23rd (to-day).

PHYSICAL SOCIETY.

5 p.m. At the City and Guilds Technical College, Leonard-street, Finsbury, London, E.C. Papers to be read : "On Maintained Oscillations in Triode Valve Circuits," by Dr. J. H. Vincent ; "Measurements of the Chief Parameters of Triode Valves," by Dr. W. Eccles ; "Measurement of Amplification of a Radio-Frequency Amplifier," by Mr. F. W. Jordan, B.Sc. ; "On the Measurement of Amplifications given by Triode Amplifiers at Audible and at Radio Frequencies," by Mr. F. E. Smith, F.R.S. Exhibition of a Method of Determining the Hardening Temperature of Steel, by the Hon. C. W. Stopford and Mr. C. R. Darling : and an Exhibition of a Thermal Cell of Constant Voltage, by Mr. C. R. Darling.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "Recent Advances in Utilisation of Water Power," by Mr. E. M. Bergstrom.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

6.15 p.m. At the Literary and Philosophical Society, Westgate road, Newcastle-on-Tyne. Paper on "Some Suggested Developments of Laying-off for the Speeding-up of Ship Construction," by Mr. I. C. G. Cooper.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecture on "Evaporation in the Chemical Industry," by Mr. J. A. Reavell.

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, London, W. Discourse on "Researches at High Pressures and Temperatures," by the Hon. Sir Charles Parsons, K.C.B., F.R.S.

MONDAY, Jan. 26th.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH-EASTERN CENTRE.

7.15 p.m. At Armstrong College, Newcastle. Paper on "Failures of Turbo-Generators and Suggestions for Improvements," by Mr. J. Shepherd.

TUESDAY, Jan. 27th.

THE INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. At Great George-street, London, S.W.1. Papers to be further discussed : "Whitby Harbour Improvement," by Mr. James Mitchell ; "The Design of Harbours and Breakwaters with a View to the Reduction of Wave-Action Within Them," by Mr. R. F. Hindmarsh ; "Wave-Action in Harbour Areas, with Special Reference to Works for Reducing it at Blyth and Whitby Harbours," by Mr. J. W. Sandeman ; and "The Improvement of the Entrance to Sunderland Harbour, with Reference to the Reduction of Wave-Action," by Mr. W. Simpson, O.B.E.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH-WESTERN CENTRE.

7 p.m. At the Engineers' Club, Manchester. Paper on "Transformers for Electric Furnaces," by Mr. J. L. Thompson.

ILLUMINATING ENGINEERING SOCIETY.

8 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Discussion on "Colour-Matching by Natural and Artificial Light," opened by Mr. W. C. Martin.

WEDNESDAY, Jan. 28th.

INSTITUTION OF ELECTRICAL ENGINEERS.—SOUTH MIDLAND CENTRE.

7 p.m. At the University, Edmund-street, Birmingham. Paper on "Failures of Turbo-Generators and Suggestions for Improvements," by Mr. J. Shepherd.

THURSDAY, Jan. 29th.

WIRELESS SOCIETY OF LONDON.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Lecture on "A Portable Valve Set and Some Properties of C.W. Circuits," by Mr. R. C. Clinker.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At the South Wales Institute of Engineers, Park-place, Cardiff. Paper on "Recent Advances in the Utilisation of Water Power," by Mr. E. M. Bergstrom ; also at

7 p.m. At the Engineers' Club, Manchester.

INSTITUTION OF AUTOMOBILE ENGINEERS.

7.30 p.m. At the Chamber of Commerce, New-street, Birmingham. Paper on "Air Cooling of Engines," by Dr. A. H. Gibson.

FRIDAY, Jan. 30th.

INSTITUTION OF CIVIL ENGINEERS.—STUDENTS' MEETING.

6 p.m. At Great George-street, London, S.W. Lecture on "The Economic Requirements for Inland Navigation Transport in the British Isles," by Mr. R. B. Dunwoody. (Lecture II.)

INSTITUTION OF ELECTRICAL ENGINEERS.—STUDENTS' MEETING.

7 p.m. At the City and Guilds Technical College, Leonard-street, Finsbury, London, E.C. Discussion on "Quantity Production as a Panacea," to be opened by Major K. Edgcumbe.

JUNIOR INSTITUTION OF ENGINEERS.

7.36 p.m. At 39, Victoria-street, London, S.W. Paper on "The Manufacture of Hydrogen Gas by the Silicol Process for Airships and Commercial Purposes," by Mr. G. E. Lygo.

ROYAL INSTITUTION.

9 p.m. At 21, Albemarle-street, London, W. Discourse on "The Gyrostatic Compass," by Mr. S. G. Brown, F.R.S.

A Universal Inductance and Capacity Testing Bridge.

By C. V. DRYSDALE, D.Sc., M.I.E.E.

Inductance and capacity measurements have become of such importance of late, especially in connection with cable and radio telegraphy, that it is highly desirable to be able to make them with the maximum of simplicity, rapidity and accuracy. If the various methods which have been proposed for testing or comparing self and mutual inductances and capacities are reviewed, it will be found that the bulk of them are bridge methods, in which the inductance or capacity to be tested is either connected directly in one of the arms of the bridge or as a shunt to one arm. To secure accuracy it is important that the circuits should be free from interference, of minimum area, and symmetrically disposed; and to obtain direct reading, the total resistance of each arm of the bridge should generally be 1, 10, 100, or 1,000 ohms, &c.

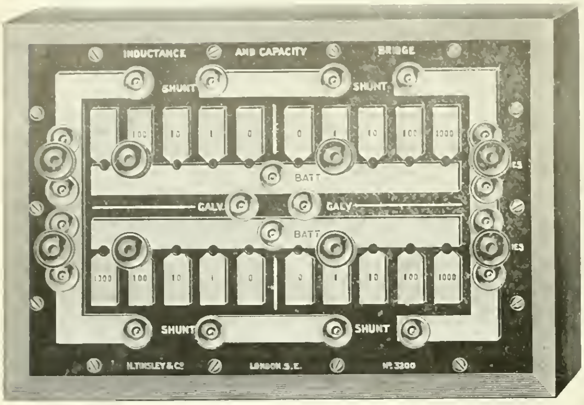

Fig. 1.

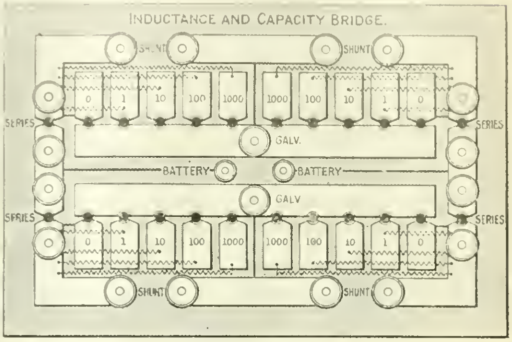

Fig. 2.—Connections of Inductance and Capacity Testing Bridge.

The simple bridge here described has been designed to fulfil the above conditions, and, as it lends itself readily to nearly every method of comparison, the term "Universal" may fairly be applied to it. Figs. 1 and 2 show the external appearance and the internal connection of the bridge, from which it will be seen that it consists simply of a plain four-arm Wheatstone bridge, each arm being provided with four coils of 1ω, 10ω, 100ω and 1,000ω (a fifth coil of 10,000ω will be added in future) and with bars and terminals enabling any circuit to be introduced in series with or coupled in shunt with any arm. In order to avoid interference, the "battery" and "galvanometer" terminals are brought close in to the centre of the bridge, so as to be joined up by twin stranded leads, and the circuits below the base are made as short and symmetrical as possible. The 100ω and 1,000ω coils in each arm are non-inductively wound on flat mica strips to minimise inductance and capacity effects.

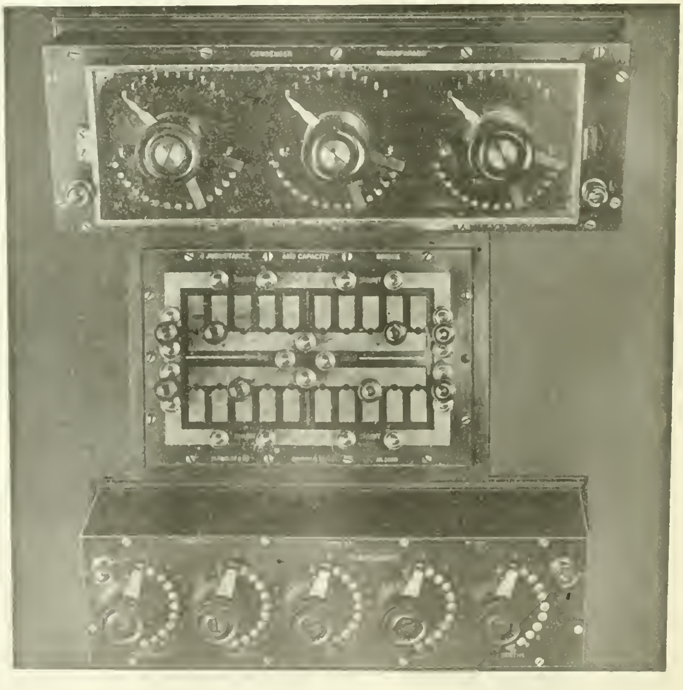

Fig. 3.—Complete Capacity and Inductance Testing Set.

In conjunction with a sliding contact resistance box, a variable standard condenser or inductance, a high-frequency alternator or buzzer, and a telephone or vibration galvanometer, the bridge is capable of being used for a large number of tests, of which examples are given below. Fig. 3 shows the complete set, with 1·11 mfd. variable standard condenser,* and five-dial resistance box. The coils in this box are wound in the ordinary non-inductive manner on brass tubes, and, according to the investigations of the Bureau of Standards, probably produces little error as regards the 10ω and 100ω coils. In the lower coils inductive effects, and in the higher coils capacity effects, probably predominate; but a special resistance box with anti-inductive and anti-capacity windings can be substituted if high accuracy is required at high frequencies.

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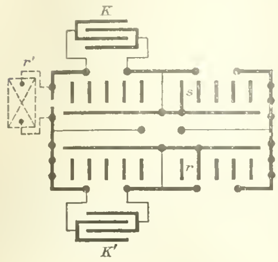
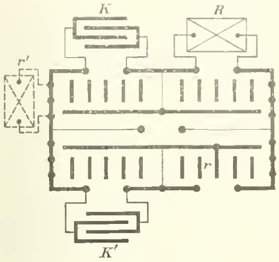
* In the illustration the condenser is only shown as of 0·999 mfd. capacity, but the higher capacity is now used.

The annexed set of diagrams, Figs. 4 to 12, show the connections for a number of the better known methods of measurement. Most of them can be arranged in a few minutes with the combination of apparatus shown in Fig. 3. The battery or buzzer and the galvanometer are not shown on most of the diagrams, as they are simply connected to the centre terminals as indicated, unless the diagram shows otherwise.



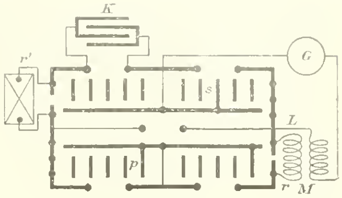
$$K' = \frac{s}{r} K.$$

FIG. 4.—DE SAUTY'S CONDENSER COMPARISON WITH VARIABLE STANDARD CONDENSER.



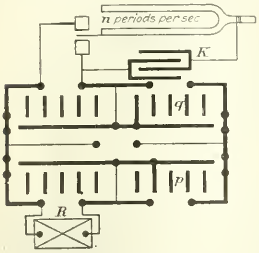
$$K' = \frac{K}{r} R.$$

FIG. 5.—DE SAUTY'S CONDENSER COMPARISON WITH VARIABLE RESISTANCE.



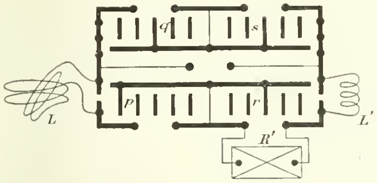
$$K = \frac{M}{(p+r)s} \quad \cos\phi = \frac{L - M(1+r'/s)}{p+r}\,\omega.$$

FIG. 6.—CAREY-FOSTER CONDENSER CAPACITY AND POWER-FACTOR TEST.



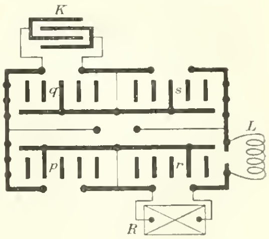
$$K = \frac{p}{qnR}.$$

FIG. 7.—MAXWELL'S ABSOLUTE CAPACITY TEST.



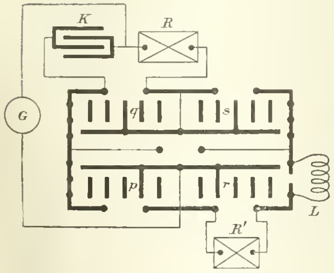
$$L' = \frac{s}{q} L.$$

FIG. 8.—MAXWELL'S COMPARISON OF SELF INDUCTANCES.



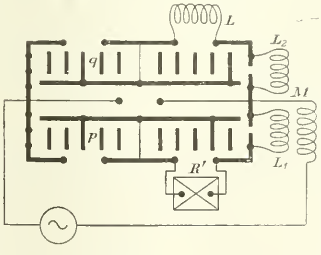
$$L = Kps.$$

FIG. 9.—MAXWELL'S COMPARISON OF INDUCTANCE WITH VARIABLE CONDENSER.



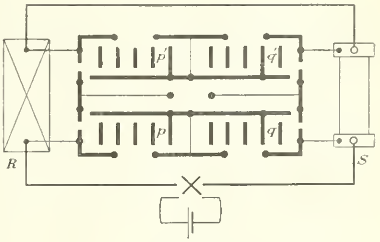
$$L = Kp\left\{R\left(1+\frac{s}{q}\right)+s\right\}.$$

FIG. 10.—ANDERSON'S COMPARISON OF INDUCTANCE WITH FIXED CONDENSER.



$$pL_2 - qL_1 = (p+q)M.$$

FIG. 11.—CAMPBELL'S COMPARISON OF SELF AND MUTUAL INDUCTANCE.



$$\text{if } \frac{p}{q} = \frac{p'}{q'}, \quad R = \frac{p}{q} S.$$

FIG. 12.—KELVIN DOUBLE BRIDGE FOR LOW RESISTANCE, OR ELECTROLYTIC RESISTANCE TUBING.

The following brief description of the tests may be of service.

A.—CAPACITY TESTS.

De Sauty's Comparison Test with Variable Standard Condenser (Fig. 4).—The condensers to be compared, K and K', are connected in adjacent "shunt" gaps on the bridge, and suitable ratios, r and s, chosen. Balance is obtained by varying K_1 and then $K' = (s/r)K$. With the variable standard condenser of range 0·001 mfd. to 1·11 mfd. the range of test is from 1 micro-microfarad (=0·9 cm.) to 1,110 microfarads. Since r and s are decade resistances, the test is direct reading.

If perfect balance cannot be obtained, there is a difference in the power factor or equivalent resistance of the condensers, and a small resistance, r', may be inserted in series with one or other condenser, as shown and the difference of power factor can readily be calculated.

De Sauty's Comparison Test with Variable Resistances (Fig. 5).—The condensers are connected as in the last test, but the resistance box R is connected in place of S, as shown. Then

$$K' = \frac{K}{r} R,$$

and if K is a condenser of 1 mfd., or a decade multiple or submultiple, the test is direct reading. With a five-dial resistance box the range is from 1 micro-microfarad or less to 11,100 mfd., with a 1 mfd. standard condenser. The difference of power factor can be determined, as before, by means of a resistance box, r', and if K is an air condenser, the actual power factor of the condenser K' can be measured.

Carey Foster Capacity and Power Test (Fig. 6). This is a useful test, in which the capacity and power factor of a condenser is measured by the aid of a variable mutual inductance. The alternator should be connected to the ordinary "battery" terminals; but the galvanometer is connected between one of the ordinary galvanometer terminals through the secondary of the mutual inductance to the middle of the right-hand end of the bridge. Then, if L is the self-inductance of the primary inductance and r its resistance, the capacity

$$K=\frac{M}{(p+r)s},$$

and the power factor

$$\cos\phi=\frac{L-M(1+r'/s)\omega}{p+r},$$

where $\omega=2\pi\times$frequency.

It is easy by a preliminary test to determine L and r and to make up $p+r$ to a decade value, when the capacity test becomes direct reading.

Maxwell's Absolute Capacity Test (Fig. 7).—The condenser K to be tested is simply connected with a tuning fork or Fleming contact maker in one of the shunt gaps, and is balanced against a resistance box, R, using an ordinary battery instead of an alternator. If n is the number of complete periods of the fork or commutator, which equals the number of times the condenser is charged per second, the condenser passes the same quantity in a given time as a resistance of $1/Kn$ ohms, and balance is obtained when

$$\frac{R}{1/Kn}=\frac{p}{q},$$

or

$$K=\frac{p}{qnR}.$$

By interchanging p and R this becomes

$$K=\frac{R}{pqn},$$

and if p, q and n have decade values, the method is direct reading. A correction is required in some cases for the resistance of the battery and galvanometer, but it can easily be made negligible.

(*To be concluded.*)

The Report of the Nitrogen Products Committee.

Terms of Reference and Preliminary.

The Nitrogen Products Committee was appointed in June, 1916, by the Minister of Munitions as a Committee of the Advisory Panel of the Munitions Inventions Department. Its terms of reference were to consider the relative advantages for this country and for the Empire of the various methods for the fixation of atmospheric nitrogen from both the war and peace point of view, to ascertain their relative costs and to advise on proposals relevant thereto, to examine into the supply of the raw materials available, and to ascertain where the large supplies of cheap power necessary for some of these processes could be best obtained, to consider what steps could with advantage be taken to increase the natural resources in nitrogen-bearing compounds, to carry out experimental work necessary to arrive at definite conclusions as to the practicability and efficiency of the processes involved and to advise as to starting operations on an industrial scale.

The Committee found it necessary to interpret the terms of reference in a liberal manner, and the inquiry has in consequence been of a wide scope, embracing a detailed examination of the nitrogen problem in its relation to the military, agriculture and industrial requirements of the United Kingdom and other parts of the British Empire. Sub-committees were appointed, and a research section was organised by the Munitions Inventions Department; and steps taken to secure laboratory accommodation to carry out the research programme contemplated. In 1916 it was pointed out by the Ministry of Munitions that while every advantage should be taken of temporary expedients, efforts should be made to promote processes which were likely to be of permanent value to the country. The Committee accordingly submitted an interim report in February, 1917, an account of which appeared in the Electrician of November 30, 1917.

The Final Report.

The final report of the Committee has now been published as a Blue Book (Cmd. 482). This report is of a voluminous character, and we are not able to do more than refer briefly to its main features. Much of the work undertaken, however, was of an important character, and the conclusions arrived at are, therefore, worthy of close study by electrical engineers, especially those engaged in the electro-chemical branch of the profession. The conclusions arrived at are of more than usual interest, owing to the reason that whenever possible the Committee obtained information direct from trade associations, manufacturers, firms and undertakings engaged in the different branches of the nitrogen industry, and from chemists and engineers who had had actual experience of the various processes involved. The committee was also in direct *liason* with official delegates of the Governments of France, Italy, Russia, and the United States, from which it obtained much valuable information regarding the position in these countries.

It should be pointed out that the report was in an advanced state when the Armistice was declared, and the sections dealing with war and post-war prospects of the nitrogen problem should, therefore, be read in the light of the fact that war was still in progress when the report was drafted.

The Importance of the Nitrogen Industry.

In their preliminary statement the Committee point out the fundamental importance of combined nitrogen in agriculture and munition work, and give a short account of the various nitrogen recovery and fixation processes. In dealing with the subject in their report they have deliberately adopted pre-war conditions as the only satisfactory basis as far as costs and prices are concerned, and it is to be especially noted that the figures for costs represent pre-war production costs at the factory, and do not include any allowance for interest, marketing, or profits, although the cost of electrical energy in all cases is taken as inclusive of capital charges upon the power installation. An addition of 20 or 25 per cent. would, therefore, have to be made to the factory costs to cover these items, and this point must be kept in view when contrasting the production costs with market prices.

It has been found a convenience in referring to the various nitrogen products to make use of expressions such as "nitrate nitrogen," "nitric nitrogen," "ammonia nitrogen," and so on, thus serving to avoid the employment of lengthy expressions such as "combined nitrogen in the form of nitrates."

The Nitrogen Industry Before the War.

Before the war practically the whole of the world's requirements in respect of "nitrate" and "nitric nitrogen" were met by the export of nitrate of soda from Chili. This is a long-standing industry, and has been characterised by a steady rate of expansion, rising from 100,000 tons per year in the closing years of the nineteenth century to over 2,400,000 tons in 1913, this figure representing an increase of 30 per cent. over the figure for 1903. According to authoritative data, the cost in England of this product was about £10·2 per long ton, free on shore, but it was pointed out that there were considerable variations in the production costs at different nitrate factories, and the average cost for the whole industry under pre-war conditions should be about £9·27 per long ton on shore. The pre-war selling price of Chili nitrate in the United Kingdom amounted to about £10·69 per long ton, equivalent to about £67·2 per metric ton of "nitrate-nitrogen." There is no doubt that the major portion of the annual consumption of Chili nitrate was utilised for fertilising purposes, the most important industrial use being the manufacture of nitric acid.

The by-product ammonia industry ranked almost equally in importance to the Chili nitrate industry, the rate of growth of this by-product being even greater than that of the Chili industry. The pre-war production of ammonium sulphate in 1913 was 1,389,790 long tons, the average annual market price of ammonia nitrogen and sulphate being £13 7s. 8d. The world's production of "ammonia" nitrogen in 1913 had increased by over 150 per cent. of that in 1903. The fact that ammonia constitutes a by-product in industries having as their main object the manufacture of other products, such as illuminating gas and metallurgical coke renders it difficult to determine the cost of actual production of by-product ammonia, but the evidence examined by the Committee indicates that the operating costs on a large scale plant would be of the order of £4 per metric ton of actual ammonia when starting with a concentrated gas liquor and of the order of £7 per metric ton of actual ammonia when starting with crude gas liquor. These figures are equivalent to £4·85 and £8·5 per metric ton of combined nitrogen, and are exclusive of the cost of impure liquor and any allowance for losses during the process. The world's consumption of ammonium sulphate during the two years prior to the war were 1,141,103 metric tons in 1912, and 1,286,757 tons in 1913, of which amount Germany was by far the largest consumer, the United Kingdom coming fourth. About 60 per cent. of the total consumption was accounted for by the requirements of Germany and the United States alone.

As in the case of Chili nitrates statistics are not available as to the precise relations between the agriculture and industrial demand for ammonium nitrogen. The major portion of the output is utilised as a fertiliser in the form of ammonium sulphate, and owing to the fact that it does not give rise to toxic products, it is largely used in preference to Chili nitrate in tropical and sub-tropical countries.

The Manufacture of Synthetic Nitrogen.

The commercial manufacture of synthetic nitrogen products dates from the beginning of the present century, with the establishment of the arc process in Norway. In 1906 the calcium cyanamide process was successfully established in Italy, and in the subsequent years preceding the war was used in Germany, Norway, France, Switzerland, America, Austria, Japan and Sweden. The third of the established methods of fixing nitrogen, the Haber process for the synthesis of ammonia was brought to a successful commercial stage in Germany in 1913. In 1907 the Norwegian production of nitrate of lime was 1,601 tons, which had increased in 1913 to 73,214 tons, while the consumption in Norway in the same years was 215 tons and 5,500 tons respectively. In 1913 Norway exported 70,927 tons of nitrate of lime, 8,203 tons of sodium nitrite, 9,107 tons of sodium nitrate, and 22,110 tons of calcium cyanamide. In addition, there were also exported from the same country 1,125 tons of synthetic sodium nitrate and 2,108 tons of a mixed product containing sodium nitrite and sodium nitrate in equal proportions. With regard to the world's production of calcium cyanamide, in the pre-war periods this increased from 500 tons in 1906 to 156,944 tons in 1913. The largest producer was the United States, with 48,000 tons, Germany being second with 24,060 tons. With regard to the Haber process it is reported that the production of a German factory in 1913 amounted to from 30,000 to 35,000 tons of ammonium. There is no doubt as to the commercial success of the process for steps were being taken before the war to develop it further on a considerable scale.

Relation of the Various Processes.

The Committee has devoted considerable attention to the question of the probable order of the costs involved in operating the synthetic process in the United Kingdom on the basis of pre-war conditions, and it should be noted that the development of nitrogen fixation processes during the pre-war period was mainly confined to countries where cheap water-power was available. As in the case of Chili nitrate and ammonium sulphate the principal synthetic productions found their main applications in agriculture. Comparing the relative positions of the nitrogen industry in 1912, the production of Chili nitrate was 2,586,975 tons, of ammonium sulphate 1,327,508 tons, of calcium cyanamide 95,000 tons, and of nitrate of lime 75,000 tons. As far as actual tonnage is concerned, therefore, the synthetic industry only accounted for about 1·5 per cent., 2·7 per cent. and 4·1 per cent. respectively of the world's production.

Summing up this portion of the report the Committee observe that the world's demand for combined nitrogen in 1913 was nearly double the demand in 1903, practically the whole of this demand being met by the Chili nitrate and by-product ammonia industries. The relation between the output of the ammonium industry and nitrate nitrogen was undergoing modification on account of the rapid growth of the by-product industry. The Chili nitrate industry provided about two-thirds of the world's supplies of combined nitrogen in 1903 and about three-fifths in 1913. The market price for combined nitrogen during the ten years from 1903 to 1913, although showing considerable fluctuations, was characterised by a general upward tendency. The synthetic industry, although in its infancy, was in a position to place nitrogenous fertilisers upon the market at a price not comparing unfavourably with the current prices of nitrate and ammonia nitrate.

The Industry in the United Kingdom.

The whole of the combined nitrogen produced from native resources in the United Kingdom in the pre-war period consisted of the ammoniacal and other nitrogenous compounds obtained in the by-product industry. For many years the United Kingdom was the world's largest producer of by-product ammonia, but in 1911 the lead was taken by Germany as a result of the extensive development of the recovery coke oven industry in that country. The home consumption of ammonia nitrogen was relatively small, and the largest part of the output was exported in the form of ammonium sulphate, so that the United Kingdom occupied a strong position in the fertiliser markets abroad. With regard to the other forms of combined nitrogen the principal demand was for nitrate nitrogen for use in agriculture and in the manufacture of nitric acid, sulphuric acid and explosives. For all these requirements the United Kingdom was entirely dependent upon imported nitrates. A table given in the report shows that the total British production of ammonia nitrogen in 1913 was practically double the production in 1903. The recovery coke oven industry showed a remarkable expansion, the output of by-product ammonia from this source in 1913 being nearly eight times the output in 1903. The gas works industry which in 1903 could account for nearly 65 per cent. of the total output of ammonia nitrogen, exhibited a steady expansion. In consequence of the development of the other by-product industries this output represented about 40 per cent. of the total in 1913. In the case of the smaller by-product industries the output from producer gas and carboniser works had trebled by 1913, while that from shale works nearly doubled. The output from iron works remained stationary. The British exports of ammonium sulphate in 1914 were double those in 1903. The estimated home consumption for all purposes, although showing an expansion, was only 35 per cent. greater in 1913 than in 1903.

The most essential of all imported nitrogenous products to this country was Chili nitrate, the amount increasing from 116,715 tons in 1903 to 140,926 tons in 1913. The amount imported, however, annually was subject to fluctuations, though there was a general increase in the last four years. The question of imports and exports for the years 1911 and 1913 are examined in some detail in the report, from whence it appears that a total of 23,979 metric tons of combined nitrogen were imported, 82,404 tons were produced in this country, making a total of 106,383 tons. Against this 71,490 tons were exported, and 33,010 tons were known to be used, leaving 1,803 tons unaccounted for.

The Economics of Established Processes.

The economics of the established processes are gone into at considerable length in the report. Estimates of the capital expenditure and direct costs that would be involved have been prepared on the basis of pre-war manufacturing conditions. These costs are those at the factory, and do not include any allowances for interest,cost of marketing,profit, royalties, or other similar payments. The cost of electrical energy is a vital factor in the arc process and an important consideration in the cyanamide process. The chemical factories would, therefore, have to be associated with power stations of large size, especially erected for the purpose, or with the central supply stations generating electricity in bulk for general industrial purposes. It is shown that there is no immediate prospect of obtaining electrical energy from coal in this country more economically than by the use of direct firing and large steam turbo-electric units. The pre-war cost of generation at a station of this kind, having a maximum load of 100,000 kw. and a load-factor of 97·5 per cent. would, with coal at 7s. 6d. per ton, amount to £3·75 per kilowatt-year at the switchboard, inclusive of depreciation and interest. This figure has consequently been adopted as a basic one for the " possible " cost of electrical energy for operating nitrogen fixation processes on a substantial scale in the United Kingdom, and under the conditions prevailing in the pre-war period. For purposes of comparison the basic figure for British conditions has been contrasted with a figure of £1·3 per kilowatt-year for exceptionally favourable water-powers in Norway, and with a figure of £2 per kilowatt-year for the average price at which energy is purchasable, at the more recently developed hydro-electric installations in that country.

Capital Cost of Electrical Plant.

The estimated pre-war capital cost for a steam-power station of the size specified above namely, £10·26 per kilowatt of maximum load—has also been adopted in dealing with the total capital outlay required for the installation of nitrogen fixation plants in this country. After careful examination of the power requirements of the arc process, it would appear that the final output of marketable products expressed as the equivalent of 100 per cent. nitric acid, would amount to a minimum of 535 kg. of nitric acid per kilowatt-year of 8,760 hours measured at the station switchboard. The energy consumption thus amounts to 1·87 kw.-years per metric ton of nitric acid of 100 per cent. strength, or to 8·41 kw.-years per metric ton of fixed nitrogen recovered. With modern large scale electric furnaces this amount might be increased from about 10 to 15 per cent., and the power requirements thus made considerably smaller. It should be pointed out that the efficiency of the arc process is low, only 3 or 4 per cent. of the electrical energy supplied being ultimately used in the actual union of the nitrogen and oxygen. About 90 per cent. of the energy is represented by the heat of the furnace gases, and the steam raising value in these gases is very considerable, sufficient steam being raised in practice to meet all the requirements of the auxiliary plant of the arc furnace installation, as well as of all the evaporating and concentrating apparatus. Alternatively, about 13 per cent. of the applied energy can be regenerated if the whole of the steam is utilised in turbo-electric plant.

It is considered that the smallest increase in the relatively costly electrical energy required for this purpose would lead to substantial improvement in the methods employed, and the arc process might provide a useful outlet for substantial blocks of off-peak power, which would be well worthy of consideration as a commercial proposition for the manufacture of nitric acid. Under British conditions, with electrical energy at £3·75 per kilowatt year, the total cost at the factory for the manufacture of nitrate of lime and sodium nitrate by this process would amount to £58·8 and £60·3 respectively per metric ton of fixed nitrogen packed for the market. When allowance is made for interest on the capital cost of chemical plant, &c., these figures show little or no margin compared with the pre-war market price of combined nitrogen in the form of Chili nitrate. On the other hand, it appears that nitrate of lime can be manufactured under conditions where cheap water-power is available at a cost at the factory from £37 to £44 per metric ton of fixed nitrogen.

(*To be concluded*).

The Manchester-Salford "Linking Up."

Details of an Interesting 33,000 Volt Equipment.

The feature which has appealed most to the general public in the new Electricity Supply Act is the foreshadowed erection of a small number of large super-stations to meet the probable increase in demands for electric power during the next few years. Electrical engineers, however, know that useful although these stations will be, a great deal can still be done by one area assisting another and by employing some means of linking up, so as to use the plant available in a large district in the best possible manner—in a word, to get away as quickly as possible from parochialism. As we announced in our columns a week or so ago, this go-ahead policy of mutual assistance has already been adopted in the Manchester district, where on occasion the Manchester Corporation, Salford Corporation, Lancashire Electric Power Company, South Lancashire Electric Supply Company and Wigan Corporation are interconnected to work in parallel for the common good. This is a true advance. Such linking up would have been unthinkable a few years ago, but progress in electrical engineering details and in the outlook on this question have, we are glad to say, rendered this economical arrangement possible. One of the most interesting inter-linking schemes in the district mentioned above is that whereby a supply of electricity is given from Manchester to Salford. There has long been a friendly rivalry between these two cities, as anyone who has attended a function in either of them at which representatives of the other have been present knows; but we are glad to see that they have sunk their differences in so far as electricity supply is concerned.

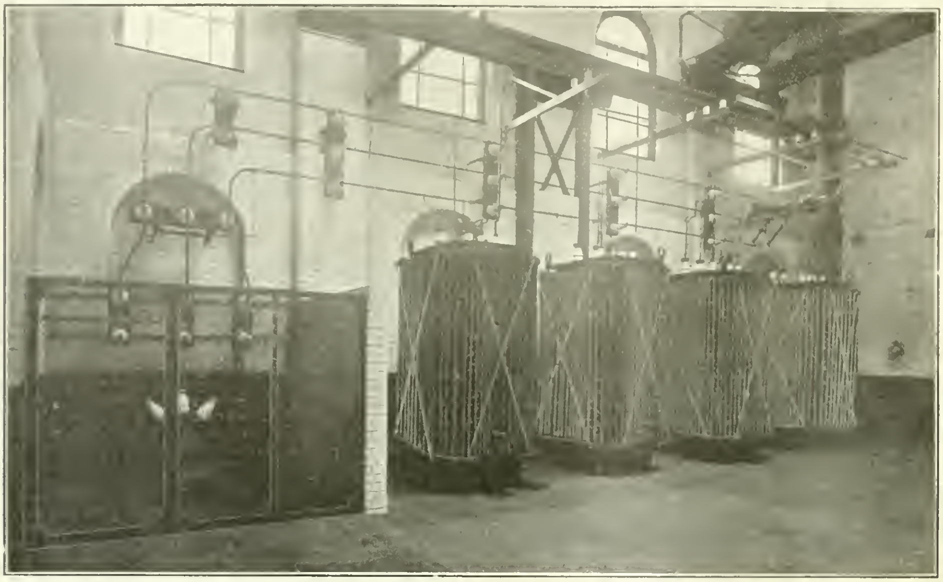


FIG. 1.—VIEW IN THE SUB-STATION AT FREDERICK ROAD, SALFORD, SHOWING 33,000/6,600-VOLT TRANSFORMERS.

At present the Salford Corporation have one generating station at Frederick-road, which, like many other generating stations of its kind, has gradually become too small for the needs of the borough, though by scrapping the old-fashioned plant originally erected and substituting for it modern turbo-generators it was possible to maintain an adequate supply for some time. Arrangements were therefore entered into between Mr. J. A. Robertson, borough electrical engineer of Salford, and Mr. S. L. Pearce, city electrical engineer of Manchester, whereby a high-tension supply is delivered from Manchester to Salford at times of peak load, and on other occasions when it might be required.

The electrical arrangements adopted are, briefly, the laying of a three-core cable from the Moss Side sub-station of the Manchester Corporation to the Frederick-road power station of the Salford Corporation. In the Moss Side sub-station the 6,600-volt supply of the Manchester Corporation is stepped-up to 33,000 volts for transmission, and is stepped down again at Frederick-road, and a connection made to the existing high-tension board of the Salford Corporation. Current is transmitted through a three-core cable

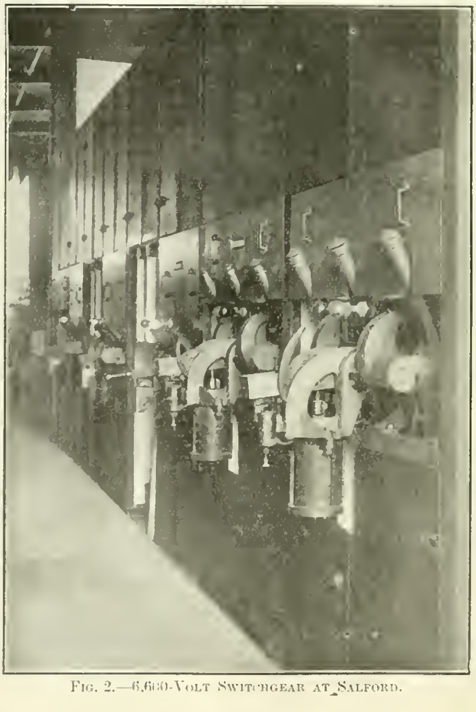


FIG. 2.—6,600-VOLT SWITCHGEAR AT SALFORD.

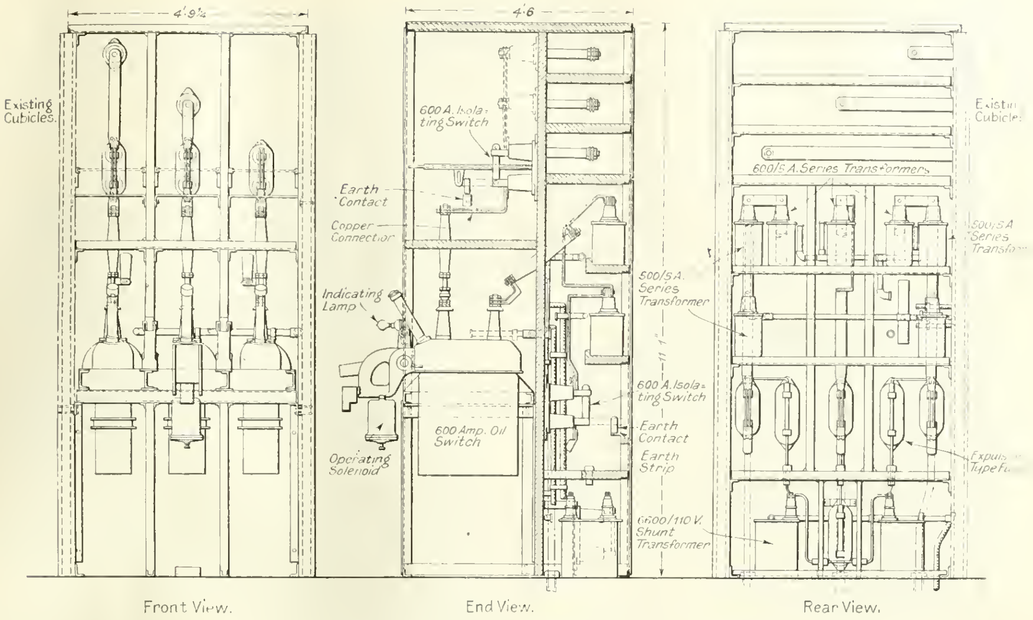


Fig. 3.—Arrangement of 6,600-volt Switch Cubicle at Salford.

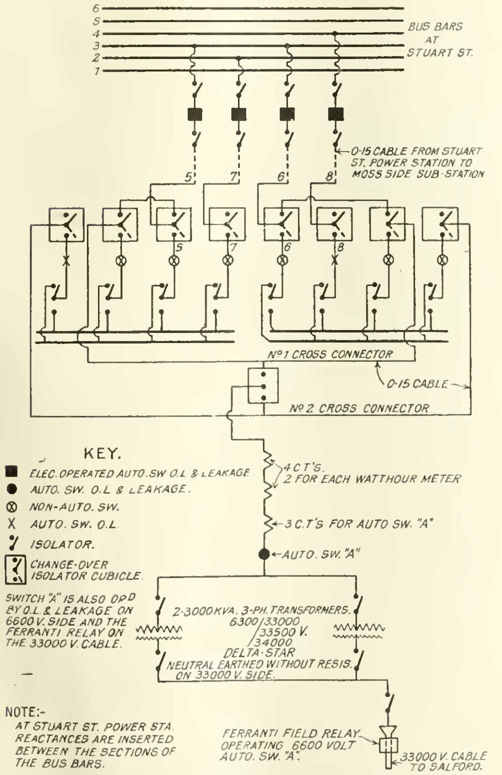

6
5
4
3
2
1
BUS BARS AT STUART ST.
0·15 CABLE FROM STUART ST. POWER STATION TO MOSS SIDE SUB-STATION
5
7
6
8
Nº 1 CROSS CONNECTOR
0·15 CABLE
Nº 2 CROSS CONNECTOR
KEY.
■ ELEC. OPERATED AUTO. SW O.L & LEAKAGE
● AUTO. SW. O.L & LEAKAGE.
⊗ NON-AUTO. SW.
X AUTO. SW. O.L
ISOLATOR.
CHANGE-OVER ISOLATOR CUBICLE.
4 C T'S. 2 FOR EACH WATTHOUR METER
3 C.T'S FOR AUTO SW. "A"
AUTO. SW. "A"
SWITCH "A" IS ALSO OPᴰ BY O.L. & LEAKAGE ON 6600 V. SIDE AND THE FERRANTI RELAY ON THE 33000 V. CABLE.
2-3000 KVA. 3-PH. TRANSFORMERS. 6300/33000 /33500 V. /34000 DELTA-STAR NEUTRAL EARTHED WITHOUT RESIS. ON 33000 V. SIDE.
NOTE:- AT STUART ST. POWER STA. REACTANCES ARE INSERTED BETWEEN THE SECTIONS OF THE BUS BARS.
FERRANTI FIELD RELAY OPERATING 6600 VOLT AUTO. SW. "A".
33000 V. CABLE TO SALFORD.

Fig. 4.—Diagram of Connections showing Method of Obtaining 33,000-volt Supply from the Manchester Corporation.

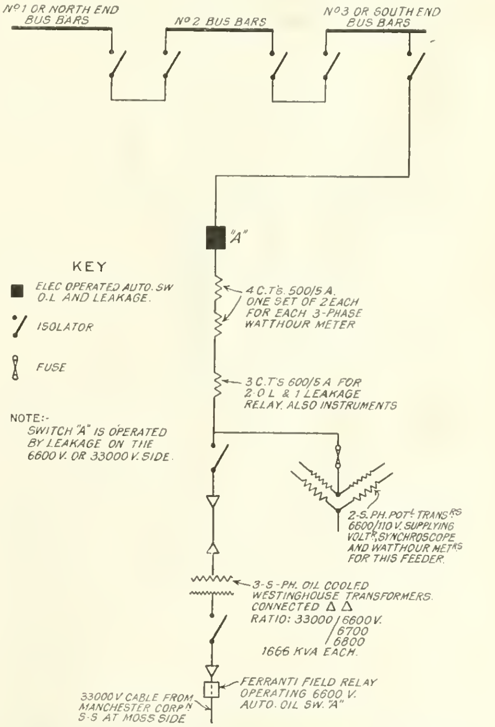

Nº 1 OR NORTH END BUS BARS
Nº 2 BUS BARS
Nº 3 OR SOUTH END BUS BARS
"A"
KEY
■ ELEC OPERATED AUTO. SW O.L AND LEAKAGE.
ISOLATOR
FUSE
NOTE:- SWITCH "A" IS OPERATED BY LEAKAGE ON THE 6600 V. OR 33000 V. SIDE.
4 C.T'S. 500/5 A. ONE SET OF 2 EACH FOR EACH 3-PHASE WATTHOUR METER
3 C.T'S 600/5 A FOR 2 O L & 1 LEAKAGE RELAY. ALSO INSTRUMENTS
2-S. PH. POTᴸ TRANSᴿˢ 6600/110 V. SUPPLYING VOLTᴿ, SYNCHROSCOPE AND WATTHOUR METᴿˢ FOR THIS FEEDER.
3-S-PH. OIL COOLED WESTINGHOUSE TRANSFORMERS. CONNECTED Δ Δ RATIO: 33000/6600 V. /6700 /6800 1666 KVA EACH.
FERRANTI FIELD RELAY OPERATING 6600 V. AUTO. OIL SW. "A"
33000 V CABLE FROM MANCHESTER CORPᴺ S-S AT MOSS SIDE

Fig. 5.—Diagram showing Connections to the 33,000-volt Supply from Manchester Corporation to Frederick Road Power Station.

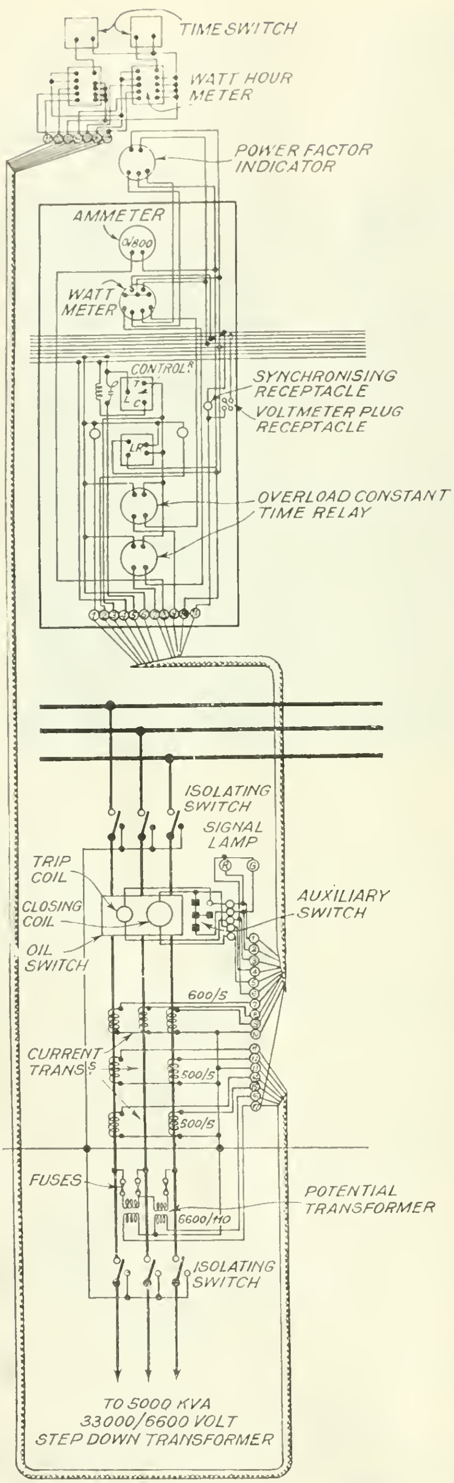


Fig. 6.—Diagram of Connections Showing Protective Gear and Measuring Equipment.

supplied by Messrs. Callenders Construction Company. Each core of this cable is 0·15 sq. in. in section; it is paper insulated and has a copper earth served with paper. The complete cable is lead covered and wire armoured where drawn into a 6 in. stoneware pipe, and where laid direct steel tapes are substituted for wire armouring. The total length from Moss Side sub-station to the Frederick-road power station is 5,780 yds., of which 3,000 yds. is in the Manchester area and the remainder in Salford.

In describing the arrangements employed we shall refer particularly to the Salford end. Fig. 1 shows a view in the special transformer room at the Frederick-road station. As will be seen, the high-tension cable is brought in to a special brick and expanded metal compartment of substantial construction, whence it passes through a three-way dividing box and the isolating switches illustrated on the left-hand side of the photograph to the step-down transformers, the connection being made by means of bare copper strip fixed to porcelain insulators. Four oil-cooled transformers, one being spare, are installed, and are shown on the right-hand side of the photograph. They are of the Metropolitan-Vickers type, and have a capacity of 1,666 k.v.a. They transform energy from 33,000 volts to 6,600 volts at a frequency of 50, the delta connection being employed on both sides of the transformer. In these transformers, coils of the same winding are separated by spacing blocks, which prevent movement, and by keeping the turns in direct contact with the oil ensure efficient cooling. Special attention is paid to the insulation. The iron circuit consists of two hollow rectangles of highest quality laminated sheet steel, with which the coils are interlinked to form, as it were, three links of a chain. The windings are separated from the shell by hardwood blocks, and are secured vertically against short-circuit by an adjustable clamping device attached to the **T** pieces. At the Manchester end two three-phase 3,000 k.v.a. transformers are installed.

On what may be called the low-tension side of the system, the transformers are connected through a three-way connecting box by means of three-core cable to a special panel on the high-tension board in the switch house. The operating part of this board is shown in Fig. 2. Fig. 3 gives front end and rear views of the switch cubicles, while Figs. 4 to 6 are diagrams of the connections employed in the scheme. It will be seen that, on the live side of this cable, potential transformers are fitted on two of the phases. There is a fuse and switch on each phase, together with current transformers for the wattmeters and for the instrument protective gear. The switchgear, which is fixed in concrete or slate cells, was supplied by the Metropolitan-Vickers Electrical Company, and follows in general details their usual design for this class of work. The bus bars pass through special self-contained cells at the top of the panel, and these, of course, form part of the general high-tension switchgear at the Salford station. The main switches are of the Westinghouse type "H" pattern, and are fitted with closing and tripping coils, the switch itself having a handle of the loose handle type. This gear is generally operated by means of a remote-control arrangement from the control board in the generating station, continuous current at 230 volts being used for the purpose. When the control switch is closed the closing coil is energised. This pulls down a plunger and closes the switch. At the same time the interlinking coil comes into operation and lights the appropriate indicator lamp. When the isolating switches are in the off position they are connected to an earthing bus bar, which, like the other bus bars, runs the whole length of the board. In addition to the usual instruments, two wattmeters are fitted, one of which registers the energy taken at peak load periods and the other the energy taken at other periods. Two Venner time switches are fitted for cutting one or other of these wattmeters in or out, to ensure that the right system of charging is being employed. The control panel is fitted with a control switch which can be placed in either the open, neutral or closed positions, and with a wattmeter, ammeter and power factor indicator. Additional protection in case of breakdown on the 33,000-volt side is provided by means of a Ferranti field relay. A leakage relay is fitted, which combines all three secondary currents in one coil on the 6,600-volt side, while the two overload relays, one on each of two phases, are also provided, these two latter type of relays being of the Metropolitan-Vickers type. It should be noted that, owing to the large current involved, the control switch does not directly close the closing coil, but energises an intermediate coil, which in turn energises the closing coil. There is thus a sort of relay effect. This closing contact is fitted with a blow-out coil. The system has now been operating some months and has given every satisfaction.

We have to thank Mr. S. L. Pearce, chief electrical engineer of Manchester, and Mr. J. A. Robertson, borough electrical engineer of Salford, for permission to publish details of this equipment, and the Metropolitan-Vickers Electrical Company for the loan of photographs and drawings.

Failures of Turbo-Generators and Suggestions for Improvements.*

By J. SHEPHERD.

(Concluded from page 63.)

The Ideal Machine.

Consideration of the usual defects already mentioned shows that air ventilation gives rise to the following difficulties: (1) Impossibility of equal distribution of air with presence of hot spots; (2) weak construction of stator, open type of end windings and serious fire risks; (3) larger diameter of rotor with greater centrifugal forces; inadequate cooling of end winding loops; (4) higher temperatures than desirable, with reduced life of insulation.

The ideal machine must be free from these defects, and should also embrace the following features:—

(*a*) Coils to be continuously held against movement under mechanical forces, but free to expand with heat.

(*b*) Working temperature and output independent of air conditions.

(*c*) Capable of working at a much reduced temperature, and to be practically fireproof.

To obtain these advantages, all windings, including rotor end loops and stator end connections, would be contained in continuous metal winding slots, with adequate freedom for expansion, and securely supported over their entire length. The heat generated in the copper would be directly conveyed to the surrounding supporting metal, and dissipated by liquid cooling.

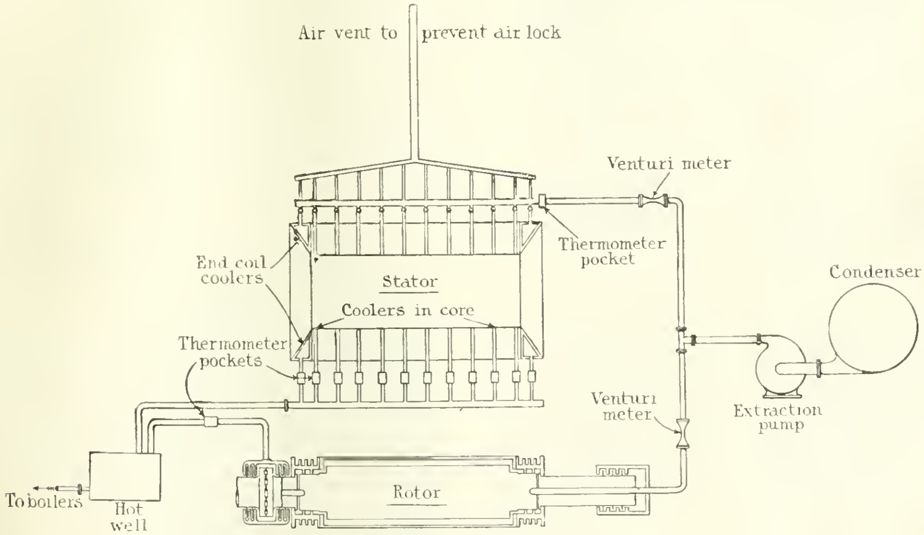


Fig. 3.—Diagram of Water Cooling.

All the liquid cooling designs on record appear to deal with the problem of heat dissipation as an adjunct to air cooling. The principle of liquid cooling avoids difficulties of cooling and cleaning, and fire risk largely disappears if there be no air to feed the flames. By splitting up the water paths in the machine, and providing adjusting cocks in the water supply to each cooling device, one could determine the temperature of each part of the machine and adjust the water flow to give a uniform temperature with elimination of hot spots. A lower temperature would be possible with enhanced life of the insulation. A further advantage would be in the provision of continuous supports to the end connections.

As a more detailed comparison of the two methods of cooling, various designs of cooling rotor windings have been drawn out for a modern high-speed rotor (Fig. 4).

The capacity of water over air cooling is very marked, as might be expected, and may be in excess of the capacity of the insulation to conduct the heat considered later.

Combination of Water Cooling and Coil Supports.

If full advantage is to be taken of water cooling, the cooling arrangements should be in close proximity to the coils, with low resistance heat paths, to serve the double purpose of coolers and coil supports. In the original Paper the author presents a series of designs embodying these features.

Water Cooling.

When arranging the water circulating system, due regard must be paid to the risk of corrosion and to the recommendations of the Corrosion Committee of the Institute of Metals, viz.: (1) Only clear water to be used; (2) water to be free from gases in suspension or solution; (3) water must be neutral, or only very slightly alkaline.

The cooling water is taken from the condensate of the steam turbine, forced by the extraction pump through the cooling devices of the alternator and discharged into the turbine hotwell. The whole of the heat losses in the alternator would then be utilised. The return flow of each water path is shown provided with a thermometer pocket (Fig. 3), and by reducing the flow in any particular cooler a close indication of the maximum local temperature can be obtained. As every portion of stator and rotor windings would be enclosed in cool metal winding slots of necessity, the cooling would be much improved and the fire risks practically eliminated. It remains to be shown that the modifications proposed, while removing certain difficulties, do not give rise to others. The problem is the construction of stator cooling devices capable of withstanding a water temperature of about 120 F. and a pressure of 50 lb. or less per square inch; the devices must also have sufficient strength to withstand the short-circuit stresses on the stator. The rotor cooling devices are subjected only to the internal water pressure and stresses resulting from centrifugal forces. Adequate mechanical strength can be given to these devices by the use of suitable material, properly proportioned.

All joints can be constructed as in hydraulic or high pressure superheated steam practice. Fusion welding is now an accepted construction of high-pressure boilers and steam piping. One can ensure no movement of the coils, no leakage of the water devices, and no overheating of the coils. Under such conditions, failure of machines should be infrequent. Should a short-circuit in a machine occur, the walls of the cooling ducts may become fused, in which

Size of alternator, kw.	Internal loss, per cent.	Quantity of cooling media.			Size of external ducts.			Per cent. of condensate for 50 deg. rise.	Increase of hotwell temperature.
		Air.	Water.			Air.	Water.		
		Cub. ft. per min.	Cub. ft. per min.	Gall. per min.	Sq. ft.	Diameter.	Diameter.		
5,000	5·5	27,500	6·6	41·2	18	5 ft.	2½ in.	41	15·5 deg.
10,000	5·0	50,000	12·0	75·0	33	6 ft. 6 in.	3½ in.	39	15·0 deg.
20,000	4·5	90,000	21·6	135·0	59	8 ft. 9 in.	4½ in.	36	13·5 deg.
50,000	4·0	200,000	48·2	300·0	133	13 ft.	6¾ in.	32	12·5 deg.

extreme case a jet of water would immediately flood the machine. Thus whilst water cooling will remove many of the risks inherent in the ordinary air-cooled machine, there is nothing in its application that presents any real difficulty.

General Comparison of Air and Water Cooling.

In modern turbo-generators of large capacity, over 95 per cent. of the heat is carried off by the ventilating air. The losses in turbo-generators differ with various designs, but representative figures are given below, together with the relative amounts of air and water necessary for cooling on a liberal scale.

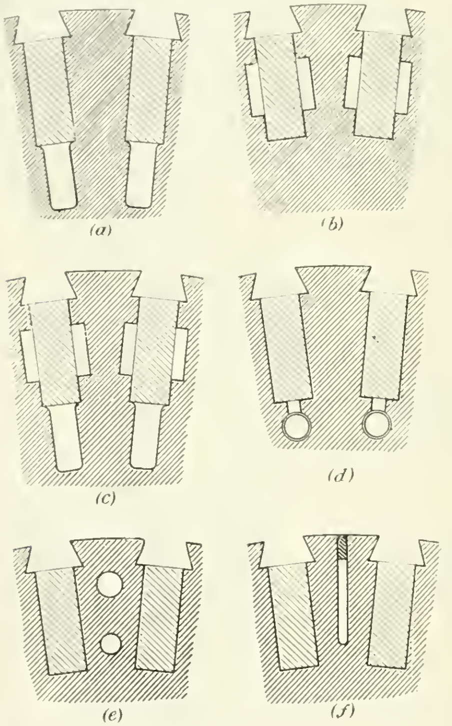


Fig. 4. Stator Winding, Various Methods of Cooling. (*a*), (*b*), (*c*), air cooled. (*d*), (*e*), (*f*), water cooled.

The relative cooling capacities of the *internal* stator ducts of equal volume would be :—

$$\frac{\text{Water ducts with water velocities of 500 ft. per min.}}{\text{Air ducts with air velocity of 4,000 ft. per min.}} = 420.$$

This increased potential capacity for cooling might be in excess of the capabilities of the remainder of the machine to transmit the heat to the cooling ducts through the insulation around the copper.

The laws of thermal capacity may be stated thus :

A (heat) current passing through a (thermal) resistance gives rise to a difference of pressure (temperature) across the resistance. In other words a hot insulated conductor passing heat through the insulation is always hotter inside the insulation than on the outer surface of the insulation being cooled. As the interior surface of the insulation must never exceed the safe temperature of the insulation, no matter how cold be the outside of the insulation, a limit to the maximum heat flow through the insulation is soon reached.

The thickness of insulation usually lies between 0·1 in. and 0·2 in. We assume, for example, a stator coil with insulation 0·10 in. thick has an outside temperature of 100 F., and is insulated with micanite built up with 11 per cent. shellac. If the inside temperature is not to exceed 150 F. the temperature gradient must be 50 F. or less ; to be within that figure, the heat density must not exceed 0·86 watt per square inch of that portion of the insulation which is conducting away the heat.

The cooling effect of water is so considerable that without certain precautions, condensation difficulties may arise. Thus, in order to prevent atmospheric condensation one should use cooling water with an inlet temperature higher than the dew point, as by the method shown in Fig. 3.

As the output of most machines is rated by ultimate temperature, there are substantial grounds for concluding that water cooling will allow an increase in output for the same total weight and volume of 25 to 33 per cent. Some readjustment of relative copper and iron losses may be necessary, and the result should be a substantial reduction of average temperatures and weight for the same output.

There are a number of cases where water cooling offers advantages over air cooling, quite apart from the improved and more robust construction of machines, *e.g.* :—

1. In hot climates where cool air is difficult to obtain.
2. In extremely dirty and sulphurous atmospheric conditions.
3. At high altitudes with reduced air density.
4. On board ship, where air cannot be freed from salt spray.

As an example of turbo-generators working at high altitudes, the stations on the Rand may be cited. At an elevation of 6,000 ft. and a barometer of 24·5 in. the air density would be 82 per cent. of normal, and a standard turbo-generator frame of 10,000 k.v.a. would only be suitable for an output of approximately 8,500 k.v.a. air cooled. The same frame if adapted for water cooling would probably give an output of 12,500 k.v.a.

Heating and Cooking Notes.

Save Us from our Friends.

Comments and articles in the daily Press are an evident sign that electrical heating and cooking are attracting more serious attention than that of the passing novelty of the moment ; but one cannot help regretting the submarine attack which was recently made by a contributor who signed himself as an " Electrical Correspondent " in " The Times Engineering Supplement." We would remind him that it is a customary trait of English people to belittle everything new ; and reference back will provide much evidence that electric light was predoomed to failure, except as a luxury for the idle rich ; electric power was " proved " to be an economical absurdity ; and electric trams were received with just as much sarcasm as the motor car and motor bus endured in their early days. In just the same way arguments have been produced to show that electric cooking and heating never can be a commercial success, and such arguments continue to-day in spite of the success achieved in commercial and industrial heating and cooking by electricity during the war period.

We quite admit that undue optimism can cause considerable harm to a good cause, but infinitely more harm can be caused by undue pessimism. To realise faults with a view to remedying them is sound policy, but we can quite well leave it to the gas people to do all the decrying and slinging of brickbats that is needed. This correspondent proceeds to show that if heating and cooking apparatus was installed in small houses the distributing arrangements of supply authorities would be inadequate to meet the demand for current. But he forgets that no one supposes that there will be a sudden conversion of all possible consumers to electric cooking. The establishment of all new methods takes time, and naturally with time supply systems will be enlarged and improved. Standing still means stagnation and decline, a phenomena which is certainly not taking place in the electrical industry.

It has got to be realised that the present generation of townsfolk have been bred and borne with gas cookers, and time is required to develop their ideas and to educate them up to the advantages of the cleanliness, convenience and ultimate economy of electrical methods. In the same way there are country folk who have never used a gas cooker. The stages of development will naturally be gradual, and that is where the value comes in of small electrical cooking appliances as educative missionaries. The iron, toaster kettle, coffee percolator and milk boiler each have a decided value as a means of introducing electrical cooking into the home. They are the small samples, so to speak, that ultimately lead to the large order. The quantity of electrical energy used by each of these pieces of apparatus may not be large but they offer a decided aid to the supply authority in that they demonstrate the advantages of electrical methods. The all-electrical home can only come by easy stages, but it will eventually come none the less for that.

As a final shot this correspondent, in referring to the all-electric home, makes a statement referring to the high cost of the apparatus as a deterrent to progress. One might equally argue that the high cost of furniture prevents persons starting homes, but hire-purchase schemes have remedied that difficulty. By studying advertisements and shop windows one can find many articles of equal price which are finding a ready sale. Only the leading stores have learnt the art of developing the purchasing habit amongst their customers; of displaying the goods to the best advantage and of creating the desire to possess. This is development work which is only just beginning in the household electrical industry. Once create a fashion for electrical methods of cooking, heating and cleaning, and the battle will be more than half won. It is up to every supply authority, contractor and manufacturer to do their bit towards this end, both directly themselves and indirectly through the Electrical Development Association.

Nevertheless, despite the gloomy references which we have criticised, there are bright spots of evidence that progress is taking place. In the joyous comedy at the Criterion Theatre we have a kitchen scene, and the equipment is all electric, and repartee in which a coal stove is stated to be worse and a gas stove the worst possible. Nor do we stop there, for in the opening scene Mr. Cyril Maude is revealed in the act of taking an electric light bath. We can remember at one time the "Daily Mail" was often referred to in a jocular manner, and has since developed into a journal with a huge circulation and a reputation for doing things. This up-to-date journal recently showed its enterprise by inaugurating a prize scheme for designs for houses, and yet despite the propaganda on behalf of gas which has recently found its way into this paper's columns, we find on looking into the prize-winning designs for towns that electricity reigns supreme. In the winning design there is an electric range, washer and wringer, together with a hotplate in the dining room to facilitate the service of hot meals. An anthracite stove provides hot water, but we did not succeed in finding gas for lighting, heating or cooking.

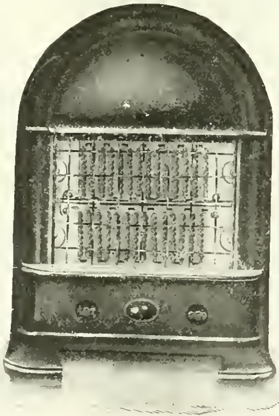


Fig. 1.—Helix Fire. 1,500 watts. Cast Front.

The Marsh Patent.

Some interesting extracts from a Paper read by Mr. W. N. Stearns before a recent convention of the N.E.L.A. of America are given in a recent issue of the "Electrical World." The patent granted in February 6, 1906, to A. L. Marsh, covers a nickel-chromium resistance element. The Hoskins Mfg. Company, of Detroit, bought the patent, and in 1913 brought a successful suit for infringement against the General Electric Company, and ultimately the General Electric Company purchased a one-third interest in the patent. The Hoskins Company at this time were also proceeding against one of the largest supply authorities for damages based not only on merchandising profit, but also on the sale of energy consumed by infringing devices. This latter point raises a decidedly interesting and novel claim, and it is to be regretted that when the General Electric Company purchased an interest in the patent the suit against the supply authority was dropped. In the contract between the Hoskins Company and the G.E.C. it was provided that the G.E.C. would be relieved from the payment of royalties for the future, but for their own protection the Hoskins Company insisted that the prices of all apparatus made by concerns under licence of this patent should be sold at fixed minimum prices. No reputable manufacturer who was engaged in the manufacture of heating appliances previous to October 15, 1915, was refused a licence under the Marsh patents, but at the present time any manufacturer who applies for a licence has to prove that the apparatus differs radically from apparatus manufactured at the time of his application for a licence; that is, those manufacturers who invested money in early development work are to a certain extent protected against new competition now that designs have been more or less perfected.

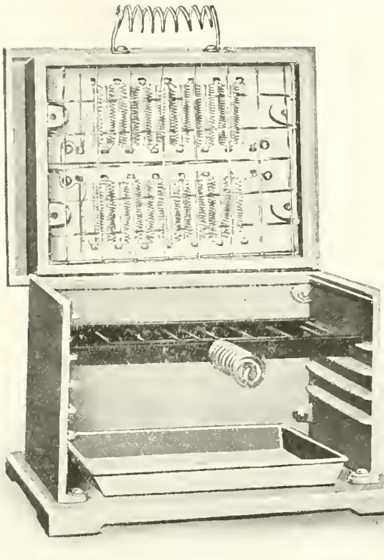


Fig. 2.—Helix Electric Grill, showing Hinged Top lifted up Consumption, 1 kw. Finish, Galvanised Cast-Iron.

Sapid Osmazome Soluble in Alcohol.

We are indebted to the "Gas Journal" for the above title. According to our contemporary, "Osmazome" is the chemical name applied by Thénard to that portion of the aqueous extract of meat which is soluble in alcohol, and contains those constituents of the flesh which determine its taste and smell. The "Gas Journal" claims that the experience of large catering concerns is that unless meat is cooked to such an extent and in such a manner that it loses between 18 and 24 per cent. of its weight, it is unfit for supply to the public. . . . . "Cooked under the conditions of the electric oven the meat remaining in a flabby condition all the time and with only 10 per cent. loss of weight—the nutrients escape and form a jelly in the dish; and to the extent of this exudation the meat is less nutritious. . . . The exact opposite to the result of proper cooking in a gas oven. The concentration of the nutritious juices by the additional evaporation of the water content of the meat to an extent representing the difference between 10 and 20 per cent. of the weight, provides the appetising flavour and the "sapid osmazome," without which meat would be regarded by 999 people out of 1,000 as poorly cooked."

We wonder who first found out that all the "sapid osmazome" was contained in the second 10 per cent. loss rather than in the first. Surely if the osmazome is in the meat and does not evaporate it makes no difference whether the water loss is 10 or 20 per cent. Further, we do not admit that by saving a loss of weight in cooking the ultimate result is a flabby product. We do know that there is no flavour of gaseous products of combustion when electrical methods are employed, also that our wives do not inform us that the dinner is late because the gas pressure has gone down or because the pipes want blowing out. We wonder what Mr. Pussyfoot will have to say about "sapid osmazome" soluble in alcohol. The journal in question does not inform us whether the full benefit of the "sapid osmazome" is best obtained by drinking a whisky and soda with one's dinner. Perhaps our readers will try this experiment for themselves.

Helix Electric Fire

Yet another newcomer to the field makes its appearance in the form of the Helix Fire (Fig. 1), manufactured by Mr. H. W. Sullivan. The element consists of metal strip wound in the form of a continuous helix and supported on a fireclay base. At the points of suspension the helix is straightened out, but the metal clip support absorbs some of the heat and prevents overheating at these points. The elements are of standard size and consume 750 watts. The standard elements are mounted together with the switches into a metal box shaped frame which can be attached to the fire front by means of two screws. All the switches employed are of the rotary type, a practice to be commended because a good type of rotary switch gives a far better "break" than with a tumbler switch and prevents the pernicious practice of operating the switch with the foot.

The household and office fires are made in three sizes, 750, 1,500 and 2,250 watts respectively, a number of finishes being available in various vitreous enamels, or the standard plain matt black finish can be had if preferred. In addition there is a 1,500 watt workshop type of fire which consists of a pair of elements mounted in a metal box frame with lugs provided to facilitate wall mounting. A small grill (Fig. 2) is also made and consumes 1 kw., it measures externally 9 in. in height, 11 in. in width and 10 in. deep. It is made of cast-iron and has a galvanised finish. The grid shelves are designed to allow the grid to be raised or lowered without removing the grid pan, and the top of the grill will lift up, so that if desired it is possible to turn the food over in the grid pan without moving the pan away from the grill. This certainly facilitates cleaning and repairs when necessary. A wire guard protects the elements from accidental contact. This is a feature that might with advantage be more employed, as in many grills there is risk of accidental contact with the elements when employing a fork to turn the food over.

The Electrification of the Melbourne Suburban Railways.

Interesting Application of the H.T. Direct-Current System.

(Concluded from p. 59)

Supporting Structures.

The supports for the catenary construction consists of pairs of tensioning anchor structures (Figs. 7 and 8), about 3,000 ft. apart, with light intermediate structures 300 ft. at intervals on the straight track, and closer on curves. Fig. 4 shows the supporting structures on a curve. All overhead equipment structures, signalling bridges, and overline road bridges to which line work is attached are bonded to the track rails through a paper spark-gap, 0·001 in. thick, between two aluminium discs, so that they are normally insulated from the rails. This is necessary to limit the unbalancing of current through the impedance bonds connecting the signalling track circuits, which are operated by super-imposed alternating current. Should the insulation between the overhead wires and the supporting structures break down the spark gap punctures and the structure is connected to the nearest rail until the fault is corrected. The standard intermediate structures have been designed and adapted to carry, where possible, the single arm power-operated signals. They are also designed to carry a distributed signal load of about 6 tons.

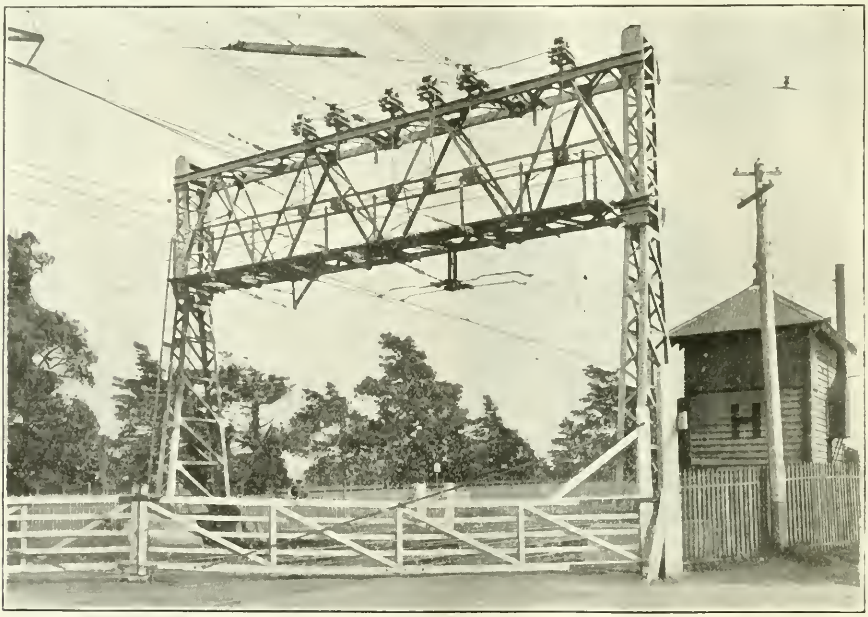


Fig. 7. View of Tensioning Structure over Two Tracks.

Sectioning and Insulation.

The up and down tracks of all routes can be electrically insulated from each other, and all routes are, as far as possible, separately fed. At extensive junctions the overhead wires of a number of tracks are connected together and treated as one section, and are usually tensioned at both ends. An air section insulator is employed between track sections, where the speed of trains exceeds 25 miles per hour. Over cross-overs and leading-in tracks to sidings where train speed is restricted, the tracks are electrically insulated from each other by means of section insulators in the catenary and contact wires. Sectioning points are located with reference to traffic requirements and the position of cross-overs, being on the outlying lines from 2 to 3 miles apart.

The system as a whole is divided into sections which extend beyond sub-stations, and which are divided into sub-sections while sidings and terminal tracks leading from the sub-sections are divided into branch sections. There is a very complete system of track circuiting and electric signalling. On the ends of the sleepers opposite "stop" signals are installed automatic train stops, operated through gearing by small induction motors.

General Description of Sub-stations.

Fifteen traction sub-stations are being provided, and there are in addition two tramway sub-stations, one at Elwood for supplying the St. Kilda-Brighton electric tramways, and the other at Sandringham, for supplying the Sandringham-Blackrock tramway. At Spencer-street a sub-station is also being built to take over the supply of lighting to Flinders-street, Spencer-street and other stations, as well as to supply the State Government offices and power to the railway workshops. There are two static sub-stations, one at Newport workshops, and one at Jolimont workshops.

The sub-station buildings are of brick, with flat concrete roofs covered with malthoid. Special attention has been paid to the ventilation, numerous large screened openings being provided in the basement and vertical louvres above the roof level. Each traction sub-station building of two or more bays for the rotaries, with an unloading bay, and the larger sub-stations have a bay for signalling equipment, the switch house and operating gallery being in an annexe to the main building. Each rotary is installed in a separate compartment, so that during the starting up and operation of any particular rotary the chamber is screened off, the locking gear on the entrance gate being inter-connected with the 20,000-volt switches controlling the supply to the rotary static transformers and also with the operating levers controlling the 1,500-volt direct-current gear, so that it is impossible for an operator to come into contact with live metal.

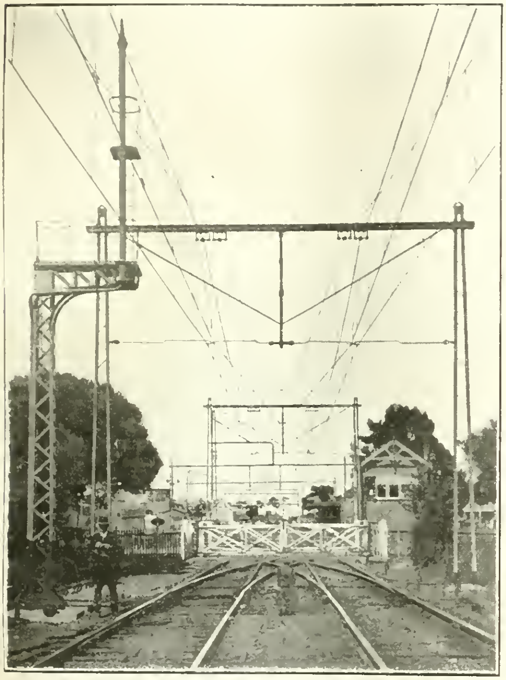


Fig. 8.—Overhead Work showing Scissors' Crossing.

High-tension Sub-station Switchgear.

The 20,000-volt Reyrolle switchgear is of the cellular type, the cells being constructed of brick and the cell doors are completely interlocked with the main oil switches and isolating switches, so that access cannot be obtained to live conductors. The switchgear is arranged on three floors. On the ground floor are installed the cable terminal boxes, earthing and isolating switches and instrument transformers; on the first floor are installed the oil switches, which are of large breaking capacity, each unit consisting of three single-phase switches in strong steel tanks. The whole connections in the oil-switch cell are insulated, and the doors to the cell are dust tight. The gallery giving access to the switch cells is open to the outer air, so that in the event of a fire occurring in one switch cell, it can be dealt with from the outside. The oil switch tanks are provided with vent pipes which discharge the gases formed when opening circuit into the open gallery; on the second floor are the bus bars and bus bar isolating switches. These bus bars are split by means of a section switch, so that maintenance work and repairs can be carried out without shutting down the whole of the sub-station. The operating gear for the 20,000-volt switches and isolating switches is on the operating gallery, which is in front of the oil-switch cells.

Direct Current Traction and Auxiliary Switchgear.

The 1,500-volt direct-current switchgear and the positive bus bar are installed on the ground floor below the operating gallery, and all isolating switches and circuit-breakers are operated by signal levers from the operating gallery above. The switchgear is mounted in brick cells with the automatic circuit-breakers on the top. The chamber containing the switchgear and circuit-breakers is specially ventilated. The negative and equaliser bus bars are run in the basement below the rotary converters. The 2,200-volt single-phase signalling switchgear is of the Reyrolle armour-clad type specially developed for the purpose. It is installed on the operating gallery. The 440-volt switchgear for controlling the auxiliary and signalling supplies is of the Metropolitan-Vickers ironclad type, and is mounted on the gallery above the auxiliary transformers, in one bay of the main building. The 110-volt direct-current switchgear for controlling the lighting motor generators, the tripping and operating battery, &c., is of the usual slate panel type, and is mounted upon the operating gallery.

Rotary Converters.

Four sizes of rotary converter are at present in use of buildings made by Siemens Bros. Dynamo Works, the Metropolitan-Vicker Electrical Company, and the General Electric Company (of New York), the two-hour ratings being 3,000 kw., 2,250 kw., 1,500 kw., and 750 kw. respectively. The 750 kw. machines, being destined for installation in outlying sub-stations with a comparatively infrequent train service, have been specially designed with a drooping characteristic, since the overloads are relatively more severe and the regulation of less importance.

The conditions laid down were the conversion of three-phase current at 19,000 volts 25 cycles into direct current at 1,500 volts, with a leading power factor of 0·95 at normal load. A compound winding on the larger sizes compensates for a drop in pressure of 10 per cent. at double full-load. The machines are six-phase with 12, 6 or 4 holes. They are arranged for self-synchronising. The 3,000 kw. machines are designed to carry 6,000 kw. for short periods and *pro rata* in the case of the other sizes, except in that of the 750 kw. machines, which are designed to carry 2,000 kw. for short periods.

The Distribution System.

Thirteen 20,000-volt feeders radiating from the Newport power house to the sub-stations in the central area are included in the present scheme, nine being of 0·15 sq. in. and four of 0·1 sq. in. C.S.A. Paper-insulated, lead-covered, wire-armoured cables are employed, all of the split conductor type. The cables are mainly laid in trenches in the streets, owing to the very limited space available alongside the railway lines. The trench averages 4 ft. in depth, and the cables are 1 ft. 9 in. between centres, covered by boards. Special precautions are taken in the cast-iron joint boxes to prevent air pockets being formed when being filled with compound. In the outlying districts the supply to the sub-stations is provided by overhead transmission on the track equipment structures. The overhead transmission lines are carried on brackets extending from the sides of the masts away from the tracks, the three phases, each of two separate wires of 0·035 sq. in. C.S.A., being placed directly above one another, and supported on chain-type insulators. This enables the split conductor protection system to be employed throughout the extra-high-tension transmission system. Telephone cables are laid along the route of the 20,000-volt transmission, there being an automatic telephone exchange at Jolimont sub-station for 50 lines. This provides communication between the control room, all sub-stations and certain important signal boxes from which switching of the overhead contact wires is regulated. Such 1,500-volt direct-current feeders as are employed are paper-insulated lead-covered, and for the most part wire armoured, being of 0·75 sq. in. and in a few cases 0·5 sq. in. sectional area.

The whole of the electrification, including the power station, has been carried out to the plans and specifications of Messrs. Merz & McLellan, under the direct supervision of their local representative Mr. E. P. Grove, in conjunction with the Electrification Committee of the Railway Department.

The Annual Physical Society and Optical Society Exhibition.

(*Continued from page 65.*)

Cambridge & Paul Instrument Company.

In our last issue we gave an account of the interesting CO_2 Recorder developed by the Cambridge & Paul Instrument Company, and in what follows we shall describe some of the other instruments which have been perfected by the company during the war period.

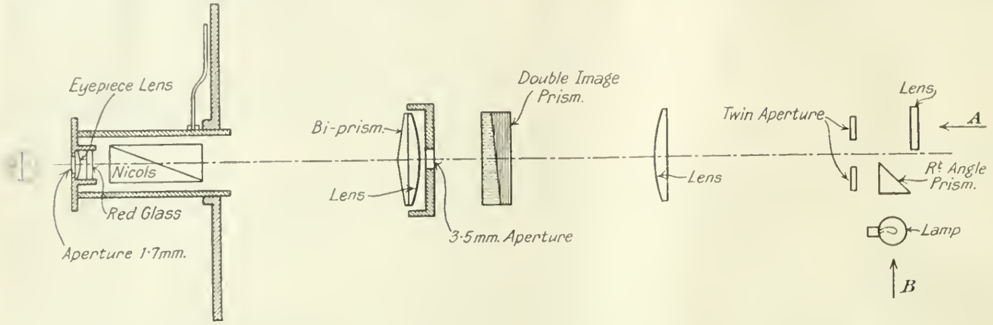


Fig. 7.—Arrangement of the Optical System of the Cambridge Optical Pyrometer.

The Cambridge Optical Pyrometer.—In these days of more accurate industrial processes in solving thermal methods there is a constant demand for means whereby high temperatures can be measured accurately and simply. Here the radiation and optical types of pyrometer claim attention, and among the latter we think that the Cambridge Optical Pyrometer is likely to prove popular. The optical method adopted is shown diagrammatically in Fig. 7. It consists essentially in the adjustment of two sources of light to equality by the rotation of a Nicol prism. The beam A is from the furnace or other source which is to be measured. The beam B is supplied by an electric lamp. The two beams pass through the system of lenses and prisms shown; they are polarised in different planes, and are rendered more chromatic, finally passing through a single eye piece. The observer sees an illuminated circular disc of light, red in tint and divided into two semi-circles, each of which is illuminated by one of the sources, A or B. Rotation of the Nicol varies the intensity of both semi-circles until equality is reached, when the temperature is read off directly on the circular scale. The latter is very open over the greater part of the working range and the point of equality is easily judged. Since the accuracy depends upon the constancy of the light from the electric lamp the equipment includes a small ammeter and rheostat, and provision is made for calibrating the lamp against an amyl-acetate standard. The method is based upon the Paschen-Wien formula for the relationship between light intensity and temperature, which has been verified by the National Physical Laboratory, the Bureau of Standards and the Reichsanstalt. The complete outfit, which is made for four ranges between 700°C. and 4,000°C., is seen in Fig. 8.

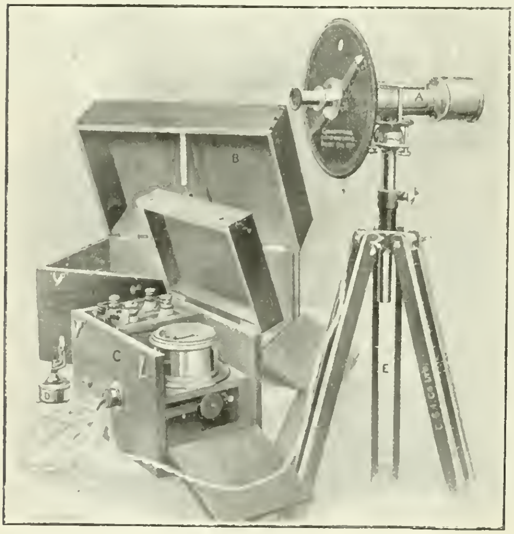


Fig. 8.—View of Cambridge Optical Pyrometer.

Cross-Talk Meter.—Turning to the more essentially electrical instruments we may mention the cross-talk meter, which is an apparatus for giving a quantitative idea of the qualities of the various pairs in a telephone cable as regards that irritating feature known as "cross-talk." The arrangement is shown in elementary form in Fig. 9, in which A and B are the two pairs under test. A high resistance R is connected so that it may be thrown across pair A, and a telephone receiver is arranged so that it may be thrown in at M or at N as desired. If the receiver is connected to M, the ordinary cross-talk is heard at D when transmitting at C. When the receiver is connected to N, and the resistance R is connected across QT, a certain proportion of the transmission will again be heard as the sliding contact P is moved away from Q so as to place the receiver as a shunt to a part of R. The measurement consists in adjusting the sliding contact, so that on switching over from N to M there is no change in the audibility. The connections of the instrument are seen in Fig. 10. The result is given directly on the dial in recognised units.

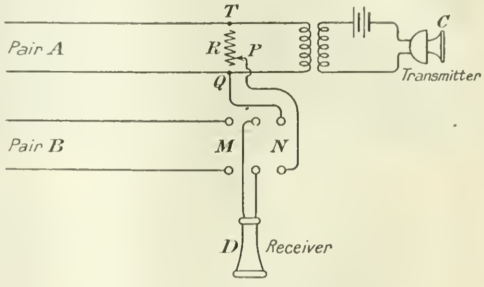


Fig. 9.—Diagram of Cross Talk Meter.

Among the other instruments exhibited by the company we noticed a cheap form of moving coil galvanometer in which simplicity is gained by carrying the complete movement in a metal box, the latter being fixed in position on the poles of the permanent magnet (of the usual circular form) by running in a lead alloy, thus sealing the two together at a sufficiently low temperature to cause no difficulty.

In working at high temperatures with thermo-couples it is, of course, an advantage if possible to use the scale of the instrument over only the working range—in other words, to work to a false zero, instead of using up perhaps half the scale over a temperature range in which no observations are desired. This desirable feature is secured in the "totally-suspended high resistance indicator" by carrying the suspended system on an adjustable head. Having made any zero adjustment that may be necessary this head is turned until the needle is brought to the maximum reading on the scale, after which the needle is brought back to zero by turning the tension head which is concentric with the other. Thus a false zero is obtained, and there is a feeling of assurance that this false zero is really a full scale deflection above the true zero.

Several instruments were shown in which the coils are wound in recesses in ebonite drums set vertical, the desired resistance being obtained by rotating the drums, the value of the resistance appearing as a straight line of figures across the row of drums. A particularly compact little bridge was to be seen on these lines. The same idea is shown in the so-called "vernier" potentiometer —a somewhat undesirable new name for the old Varley slide method; that is the shunting of two coils by ten coils in series so that the total resistance in circuit remains unaltered and a further decimal place is obtained.

Fig. 11 illustrates a convenient little instrument for the measurement of insulation (from two megohms down to, say, 1,000 ohms) and for the testing of continuity and polarity. It contains a small "Unipivot" galvanometer, a four-volt dry battery and a coil of 20,000 ohms in series with them. For more serious measurements, attention may be drawn to the long range "Omega" set (Fig. 12). This is made up with as many as ten ranges, and resistances may be measured between the limits of 100 megohms and 0·405 ohms. The ranges are varied by pulling out or pushing in the slider seen on the left-hand side, the actual range in use being indicated in the window, together with an indication whether the generator or a battery is the source of current.

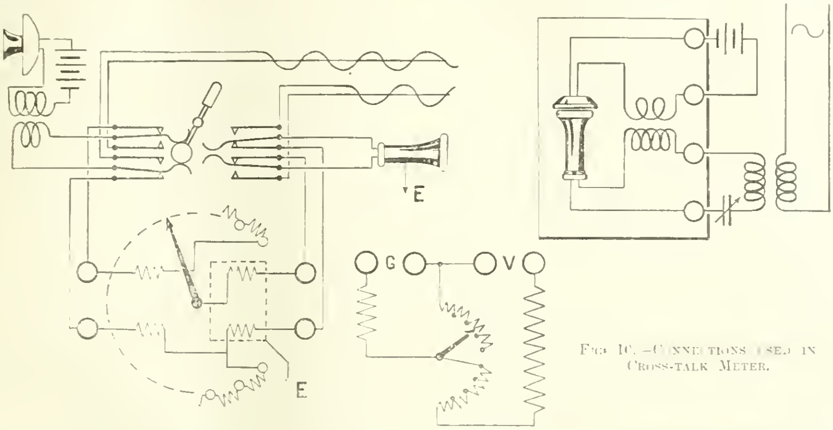


FIG. 10.—CONNECTIONS USED IN CROSS-TALK METER.

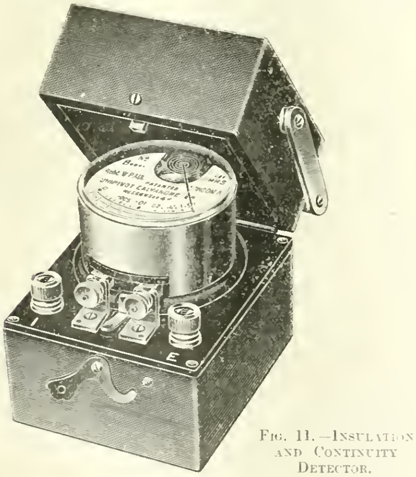


FIG. 11.—INSULATION AND CONTINUITY DETECTOR.

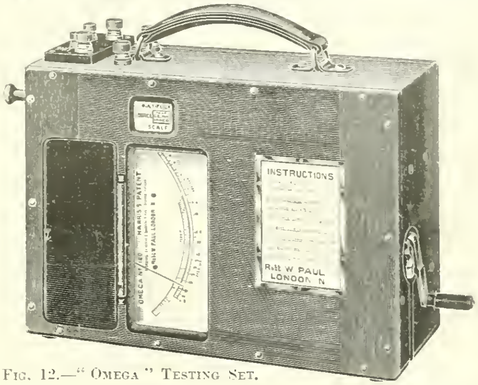


FIG. 12.—"OMEGA" TESTING SET.

(*To be continued.*)

Correspondence.

A REMARKABLE PROPERTY OF A WELL-KNOWN ALTERNATING CURRENT CIRCUIT."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the letter in your correspondence columns of the 9th inst. regarding the above matter, if you will refer to the ELECTRICIAN, Vol. LXV., pages 59 and 157, you will find correspondence relating to the matter which you ask for in the footnote under the letter from Mr. R. C. Clinker. I am, &c.,

Helsby, Jan. 14. H. HIGHAM.

[In addition to the reference given by Mr. Higham, we find that a letter from Mr. Alfred Still appeared in the ELECTRICIAN, Vol. LXV., p. 113, commenting on Prof. Howe's article, and pointing out that the observed effect was explained by the writer in his book on "Alternating Currents," published in 1898. The same effect was referred to by Messrs. Albert Campbell and J. L. Eckersly in an article on "The Insulation of Inductive Coils," which appeared in the ELECTRICIAN, Vol. LXIV., p. 350, 1909, and as long ago as 1893 by the late

Mr. H. E. Harrison in the Electrician, Vol. XXXI., p. 119, 1893. We have sent copies of the correspondence on this subject to Mr. E. B. Brown, but as he is in Melbourne it will probably be some time before his reply is received.—Ed. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to Mr. R. C. Clinker's letter to you of Jan. 1, published in the Electrician of Jan. 9, I have been unable to trace the article to which he refers: but possibly the following simple general explanation may be of service to him.

It is well known that the effect of a secondary of a transformer on closed circuit is to bring the primary P.D. and current into closer phase relationship than when the secondary is open. The attached vector diagram (Fig. 1) will make this clear:—OF represents the flux and OE_3 the induced E.M.F. in the primary. $OE_1 - OE_3$ is the applied E.M.F. required to overcome OE_3. OM is the magnetomotive force required to produce OF (the angle FOM being the angle of hysteretic lead). OC_1 is the voltage drop due to resistance to the current corresponding to and in phase with OM. Then OV, the resultant of OE_1 and OC_1 is the primary P.D.

When the secondary S is short-circuited OE_2 represents the induced E.M.F. in it and OM_2 the magnetomotive force due to its lagging current. The primary magnetomotive force OM_1 must now be such that OM is the resultant of OM_1 and OM_2. OC_2 in phase with OM_1 represents the resistance drop due to the primary current required to produce OM_1. OV_1 will now be the primary applied P.D., but the primary P.D. has not been increased: consequently all lengths are now too great in the ratio OV_1 OV. We cannot, however, say simply that the real new primary current is obtained from $OV/OV_1 \times OC_2$ since OF is reduced, and therefore also the angle of hysteretic lead. The figure, however, shows the reduction in phase angle between primary P.D. and current.

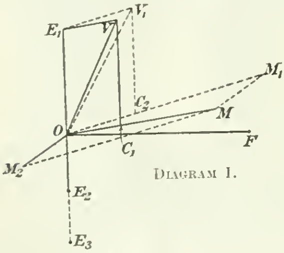


Diagram 1.

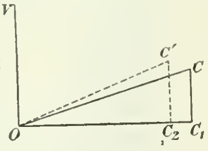


Diagram 2.

In Fig. 2 OV is the primary P.D. and OC the current with open secondary OC is made up of OC_1 in quadrature and C_1C in phase with OV. When the secondary is closed and OC swings forward to (say) OC'', although C_1C is increased slightly (*i.e.*, more power is taken) the reduction in phase angle more than compensates for this and enables OC to be reduced to OC'.

Without more details as to the number of turns, &c., on the primary, or a knowledge of the iron used it is, of course, not possible to construct exact diagrams, but I hope the foregoing will explain the phenomenon.—I am, &c.,

Woolwich, Jan. 15. H. F. Trewman.

Reviews.

Magnetos. By A. P. Young, A.M.I.E.E. (London: Iliffe & Sons.) Pp. 200. 4s. 6d. net.

Electric Spark Ignition. By J. D. Morgan, M.I.E.E. (London: Crosby Lockwood & Son.) Pp. 88. 8s. 6d. net.

These two books, both dealing with the question of the ignition of compressed gaseous mixtures, are very welcome additions to the literature which is at present available to those who desire to make more than a cursory study of the problems involved. Elementary explanations of high tension spark production and properties are unsatisfactory, but more accurate explanations depend largely on research work, which, prior to the war, had been chiefly carried out in Germany. During the war English manufacturers have developed the magneto industry and much of the progress made has depended on the researches carried out by the technical staffs of the various companies and scientific institutions.

Mr. Young and Mr. Morgan have contributed largely to our knowledge of ignition problems through the medium of scientific papers to technical journals and societies. The scope covered by the books differs considerably, Mr. Morgan having refrained from discussion of the design or construction of the ignition apparatus and confined himself to a clearly written and well thought out review of the present state of our knowledge regarding the characteristics of spark production and behaviour. The book is one which will be read with interest and profit by all whose knowledge of the subject covers the constructional details and handling of the ignition apparatus itself, but who have frequently felt at a loss regarding the explanation of some phase of the behaviour of such apparatus. The chapters on "Interaction of Spark and Gas" and "Spark Plug and Test Gap Characteristics" are particularly interesting and suggestive. The references are collected and enable anyone to get the original papers if further information is wanting. As a reference book on the philosophical side of the subject it is excellent in conception, whilst the clearness of the explanations, and of the accompanying diagrams, make the information given easily absorbed.

Mr. Young's book is designed to meet the needs of those who are actually engaged in work involving the handling of magnetos, and whilst sufficient explanation is given of the operation of the magneto, and of the properties and behaviour of the spark, much of the book is confined to descriptions of the construction and design of current English magnetos. There is a large amount of useful information regarding the manufacture and testing of magnetos which will be of interest and value to engineers, car owners, or garage staffs. A special study is made of the polar inductor type of magnetos of which the best known example prior to the war was the "Dixie." During the war, where the demands of the Air Force for magnetos suitable for eight and 12-cylinder engines had to be met, the B.T.H. Company introduced designs to meet this demand, the performances of which were most satisfactory. The comparison of the two types—viz., rotating armature and the polar inductor type—will be interesting to all users of magnetos. In addition the book contains details of the various improvements which the British manufacturers have introduced, and also the standardised dimensions and types of magnetos at present manufactured here. Those seeking information regarding the construction or operation of magnetos will find in this book a solution of many of their difficulties. It should find a place in every garage and workshop where magnetos are used as a means of obtaining ignition.

Guide to the Study of the Ionic Valve. By W. D. Owen. (London: Sir Isaac Pitman & Sons, Ltd). Pp. vii.+59. 2s. 6d. net.

This unpretentious little book is an introduction to the study of the thermionic valve. In view of the enormous advances which have been made in the development and application of electric valves during the last few years, its appearance is particularly appropriate. It is not a text book, but it will place those who have occasion to understand these developments in possession of the salient features involved. We think the author has gone too far in the direction of limiting the matter included, which might with advantage have been amplified, and accompanied by line drawings of the types of valves considered.

Rapid specialisation in science inevitably necessitates the publication of books which will find only a limited circulation, and yet which must not be unduly expensive. Such a book as the one under review will permit revision and reissue at frequent intervals in order that the most recent developments may be available in a convenient form, without risking the loss involved in the destruction of part of an edition of a more costly volume.

We can strongly recommend this book not only to students, but to all who desire to keep themselves informed of advances in this rapidly developing branch of electrotechnics.

A. P. M. F.

The Electrician.
FRIDAY, JANUARY 23rd, 1920.
Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

The Legal Position of Electricity Supply.

The Electricity (Supply) Act of 1919, which is abstracted on another page, opens a new, and we believe a prosperous period for the supply industry in this country. It involves a complete reversal of the policy inaugurated in 1882 of discouraging the association of undertakers for mutual assistance in giving a supply of electricity in bulk; it creates Electricity Commissioners, with extensive powers for promoting, regulating and supervising the supply of electricity; and the Ministry of Transport is to be entrusted with the powers and duties hitherto exercised by the Board of Trade in connection with the administration of the Electric Lighting Acts, 1882 to 1909. Though it has been alleged that in the early days of electric lighting the Board of Trade showed undue tenderness towards local authorities when there were competing applications for a provisional order for a district, and that it was reluctant to grant or to encourage the grant of any powers for which there was not clear statutory authority or any existing precedent, still its administration was fair and impartial, and during the last 10 or 12 years the Board did a good deal to encourage the development of electricity supply, and the Ministry of Transport will now take over the administration of a well-established and rapidly expanding industry, upon whose continued progress will depend the success and welfare of many other industries.

An Advance in Administration.

The new Act, which, in contrast to the other Acts relating to electricity, is not styled an "Electric Lighting Act," authorises the appointment of Electricity Commissioners (not exceeding five), and lays down their qualifications, &c. The powers which these Commissioners can exercise (apart from the appointment of a secretary, inspectors and staff) include: (1) any of the powers and duties of the Board of Trade under the Electric Lighting Acts which may be delegated to them; (2) the conduct of experiments or trials for the improvement of electricity supply or of the utilisation of fuel or water power, and these may be carried out either by themselves or through any joint electricity authority, or any authorised undertakers or other competent body; and (3) the division of the United Kingdom into electricity districts and the preparation of a scheme for the improvement of supply in any district. Such a scheme may provide for the incorporation of a joint electricity authority with all the powers of authorised undertakers under the Electric Lighting Acts, with power to purchase existing undertakings. Part of an undertaking cannot, however, be purchased except with the consent of the owners. An order of the Commissioners giving effect to such a scheme must be confirmed by the Ministry of Transport but it will not come into effect until approved by both Houses of Parliament.

We are afraid that this procedure, when there is strong opposition to the scheme, will not be more expeditious or less expensive than that which prevails at present in the case of a private bill. A good deal will, however, depend upon the Regulations to be made by the Ministry and by the Electricity Commissioners.

"Cheap and Abundant Supply."

We do not envy the task laid upon the Joint Authority by Sec. 8 of the Act, which enacts that "It *shall* be the duty of every joint electricity authority to provide or secure the provision of a cheap and abundant supply of electricity within their district." It is easier for politicians to impose a duty than to carry it out, and though a joint authority will be able to give a better and cheaper supply of electricity than any of the isolated undertakers in its district, it will not be able, owing to the increased cost of fuel, higher wages, &c., to supply at pre-war rates, and in this respect there will, we are afraid, be disappointment in store for some of the politicians and their dupes. In order to be able to fulfil their obligations a joint electricity authority, which is to be representative of authorised undertakers within the electricity district, may construct generating stations, erect transmission lines or other works, and acquire the undertakings or parts of undertakings of authorised undertakers. It cannot, however, supply electricity in any area which forms part of the area of supply of any authorised distributors (except to railway, canal or inland navigation companies for traction), or of a power company for which the company is authorised to supply electricity, without the consent of the distributors or of the company; but there is an appeal to the Electricity Commissioners against the refusal of such consent. It will be noted that sections 2 and 3 of the Electric Lighting Act, 1888, which confer the power of purchasing undertakings by local authorities, do not apply to the undertakings of these joint electricity authorities. The Electricity Commissioners may, after inquiry, impose an obligation upon a joint authority to supply electricity in such circumstances, within such areas and on such terms and conditions as to price and otherwise as may be specified in an Order. This appears to be a very useful, though flexible, provision and, provided it is reasonably applied, should be very useful for consumers. A local authority may transfer its undertaking to a joint authority, and a local authority's right of purchase may be divested by an order constituting such joint authority. This provision may arouse opposition from existing undertakings, especially those owned by local authorities, who will want to continue the distribution of electricity in their areas. We think this difficulty can be got over by authorising the joint authority to generate and supply electricity in bulk to the existing undertakers for retail distribution.

Another useful provision is that which enables a joint authority, with the consent of the Electricity Commissioners, to enter into arrangements with a local authority, company or person for the utilisation of water power, waste heat or other form of energy, and for this purpose the joint authority may acquire land compulsorily, and it may also erect and maintain by-product plants.

The Financial Clauses.

Except in London, the local authorities have hitherto been compelled to obtain the sanction of the Ministry of Health, the Secretary for Scotland, or the Local Government Board for Ireland for the borrowing of money for electricity supply purposes, but in future the powers of these departments will be exercised by the Electricity Commissioners, and a joint electricity authority must, before incurring any capital expenditure, submit plans and estimates to them. In addition it must furnish such accounts, returns, &c., as may be required by the Commissioners, who have power to appoint auditors for the purpose of auditing the accounts of the authority. This change will make for uniformity of practice in regard to the periods allowed for the repayment of loans.

There is a group of useful provisions in the Act which enables the Ministry of Transport to erect a generating station in any district within two years of the creation of a joint electricity authority, and up to £20,000,000 may be expended upon these stations, but at the end of the period the undertaking vests in the joint authority. The prices for the supply of electricity from these generating stations shall be such that the receipts will be sufficient to cover the expenditure on income account (including interest and sinking fund charges) with such margin as the Ministry of Transport think fit. Though no reference is made to an allowance for depreciation, obsolescence or contingencies, it is to be presumed that all charges properly made by a sound business concern will be included. Until a joint authority is formed the authorised undertakers may render mutual assistance for the supply of electricity, &c.

Useful Amendments.

A few useful amendments of the existing law have been made, including the right (with the consent of the Commissioners) to joint electricity authorities or authorised undertakers to contribute to the funds of any association formed for the common interests and the discussion of matters relating to the supply of electricity; and also authority to provide, let for hire, connect and maintain, but not to manufacture or sell (unless otherwise authorised) any electric lines, fittings, apparatus and appliances for lighting, heating, power, &c. The latter provision seems to us to be too restricted as it will prevent the sale of apparatus let on hire, and many consumers who wish to make an experiment in electric heating or power commence by hiring the apparatus and then, finding it successful, wish to purchase.

Wayleave Problems.

There is a long and somewhat involved clause dealing with the important question of wayleaves, but it would appear that, apart from railways, canals, docks or harbours, no new powers are conferred upon undertakers, and the difficulty of erecting overhead wires over private lands in rural districts remains. The power conferred upon the Electricity Commissioners to require any authorised undertakers to amend or alter the type of current, frequency or pressure employed by them is a useful one and should assist the effort to standardise supply and to get rid of the present bewildering range of voltages and frequencies in use. Anything which could hitherto be effected by a provisional order may be effected in future by a special order made by the Electricity Commissioners and confirmed by the Ministry of Transport, or by an order establishing a Joint Electricity Authority, but both kinds of Order do not come into force until approved by Parliament.

It will be seen that future developments depend very much upon the policy adopted by the Electricity Commissioners. Though the power to establish joint electricity authorities is only permissive there is already evidence that many existing supply undertakings will avail themselves of the opportunity of associating with their neighbours for the purpose of erecting and maintaining large generating stations, and with a little encouragement from the Commissioners no doubt the laggards will fall into line. The Act does not appear to do much for the retail distribution of electricity in rural areas. For this purpose an extensive use of overhead wires is necessary, and it is to be hoped that these and other restrictions on the free use of electricity for commercial and industrial purposes, will be removed by the new Bill promised by the Government.

The Electricity (Supply) Act.

In view of the importance of the Electricity (Supply) Act, 1919, we give below a full abstract of its principal provisions:

Electricity Commissioners.—For promoting, regulating and supervising the supply of electricity, Commissioners (not more than five) are to be appointed; but they are to act under the general directions of the Ministry of Transport. Three of the Commissioners must be selected for their practical, commercial and scientific knowledge, and two form a quorum. The Commissioners can exercise all the powers conferred by the Electric Lighting Acts, 1882 to 1909, and the present Act, including the sanctioning of loans for electricity supply purposes; they may conduct experiments as to electric supply, the utilisation of fuel, water-power, &c., and they may appoint advisory committees from the chairmen and members of joint electricity authorities, &c.

Reorganisaton of Supply.—The Commissioners may provisionally group areas into separate electricity districts with a view to efficiency, economy and convenience of administration, and notify all concerned. If there are objections, they shall hold a local inquiry; and they may, when they think the electrical organisation of a district should be improved, publish intention to hold a local inquiry, and give all concerned an opportunity to submit schemes for improvement.

Joint Electricity Authorities.—A scheme may provide for establishing, and (where desirable) incorporating a joint electricity authority representing the authorised undertakers in a district, with or without representatives of county councils, local authorities, large consumers, and other local interests; for the exercise of all or any of the powers of the authorised undertakers, and also for the transfer to the joint electricity authority of all or part of any of their undertakings, upon terms provided in the scheme; but transfers can only be by consent of owners. The joint authority can delegate its powers or duties to committees, &c

Confirmation of Schemes.—After inquiry, decisions of Commissioners may be embodied in an Order, confirmed by Minister of Transport, and laid before Parliament; but each House must approve, with or without modification, by a resolution. The Order then has effect of an Act.

Joint Electricity Authorities.—Must provide or secure the provision of a cheap and abundant supply of electricity, and they are given powers as to: (*a*) Supply of electricity within their district (including construction of stations, main transmission lines, &c.); (*b*) acquisition of whole or part of undertakings of authorised distributors. They may establish superannuation schemes for officials, and they may (by agreement) buy generating stations and transmission lines from railways, docks or private owners.

New Generating Stations.—No authority, company or person can establish new or extend existing station or main transmission line without consent of Commissioners; but restriction does not apply to private stations, but new private stations must comply with regulations of Commissioners as to type of current, frequency and pressure. Railways and docks will not be refused consent unless Commissioners think that a joint authority or authorised undertaker can give an adequate and regular supply at no greater cost. Where a group of persons require large quantities of electricity for special needs of their business (other than mechanical power or light), or a manufacturer can generate from energy derived from a process of manufacture carried on in his premises proposes to generate for his own and associated businesses, the Commissioners may let them generate; but any surplus electricity shall (if the Commissioners require) be sold to the joint authority or to an authorised undertaker, at prices fixed by the Commissioners.

Powers of Joint Electricity Authority.—A joint electricity authority has power to supply in its district, subject to the following limitations. It shall not supply (*a*) in any area belonging to authorised distributors without their consent; but It can supply railways, canals and inland navigations for haulage, battery charging and lighting vehicles and vessels; (*b*) in any area belonging to a power company without their consent, but it can supply to previous owner of a transferred station, also for vehicle battery charging. If authorised distributors or power company withhold consent, the joint authority may appeal to the Commissioners, and the Minister of Transport, on recommendation of Commissioners, may dispense with consent if unreasonably withheld.

In relation to every joint electricity authority, this Act is a special Act for the purposes of the Electric Lighting Acts; every joint authority is deemed an "undertaker," and secs. 2 and 3 of the Electric Lighting Act, 1888 (the purchase clauses) do not apply to joint authorities.

Any local authority being authorised distributors may agree to transfer all or part of its undertaking to a joint authority, with consent of Commissioners. If part of area is not in a district, it can be bought by the adjacent joint authority. The existing purchase rights of any local authority or County Council may be vested in the joint authority. Holders of such rights to have adequate representation on joint authority, and provision is made for purchasable areas extending over boundary lines, &c. A joint authority may, with consent of Commissioners, acquire by agreement the whole or part of any undertaking belonging to authorised undertakers not being a local authority. The Electricity Commissioners may by Order transfer any unserved territory from a power company to a joint authority, and may give full supply powers to the power company in other parts of their area not served by authorised distributors.

The Minister of Traosport, on representation of Commissioners, may by Order authorise any joint authority or authorised undertakers to abstract water from rivers, &c., with reservations as to existing rights.

A joint authority, and any local authority, company or person may arrange for the utilisation of water-power, waste heat or other available form of energy, and a joint authority can acquire land under sec. 1 of Electric Lighting Act, 1909, for the development of water-power, and may erect, maintain and renew by-product plant, &c.; but if Electricity Commissioners think existing concerns could properly deal with by-products business, the joint authority shall not establish by-product plant.

Compensation or deprivation of employment is given by sec. 15 of the Act, the rights of employees to be determined by a referee (or referees) to be appointed by the Minister of Labour.

Capital Expenditure.—A joint electricity authority must, before incurring capital expenditure above a limit to be prescribed, submit plans, estimates, &c., to the Commissioners.

Transitory Provisions.—The Ministry of Transport can, after consulting Electricity Commissioners, construct stations, main transmission lines, &c., and exercise any joint authority powers, at any time after a district has been provisionally determined and before establishment of joint authority; and for two years if joint authority consents.

Where it is proposed to construct a station before a joint authority is established, the Electricity Commissioners shall consult County Councils, local authorities and authorised undertakers as to the proposed site. Treasury may issue to Ministry up to £20 millions for such works and for working capital. Two years after establishment of joint authority, or earlier if agreed, any station, lines and works constructed under this section shall vest in joint authority, subject to payment by joint authority of Treasury figure of money advanced, &c. Prices to be fixed by Ministry for supply from such stations to cover all running expenditure and capital charges, with such margin as Ministry may think fit.

Mutual Assistance.—From passing of Act to establishment of joint authority, any two or more authorised undertakers may, if Commissioners approve, or may be required by Commissioners to, arrange for mutual assistance for (*a*) giving and taking supply and distributing it; (*b*) management and working of stations or any part of the undertakings concerned; (*c*) provision of capital and the allocation of receipts, &c. Terms and conditions to be agreed, or if Electricity Commissioners make the requisition, they can settle in default of agreement, but the parties remain subject to their obligations to third parties; and powers are given to break up roads, &c., for this purpose.

Amendment of Electric Lighting Acts.—The powers of the Minister of Health (formerly L.G. Board), Secretary for Scotland, London County Council, with respect to sanction of borrowing by local authorities, are transferred to the Electricity Commissioners.

The consent of a local authority is not required for above-ground lines where Ministry gives consent, and a joint authority or an authorised undertaker may place any electric line underground across any land, and above ground across any land (except when covered by buildings or gardens or pleasure grounds) in cases where such overhead lines are otherwise lawful, and right of access is given for repairs, &c. Before placing lines across lands, the joint authority or authorised undertakers shall serve notice on owner and occupier, with description of proposed lines. Ministry must decide after hearing both sides.

The power of placing lines across land include the right to cross any railway, canal, &c., subject to rights of owners and to special provisions.

Supply of Apparatus.—A joint electricity authority and any local authority authorised to supply electricity may provide, let for hire, and in respect thereof may connect, repair, maintain and remove (but shall not, unless expressly authorised to do so by the special Act or Order, manufacture or sell) electric lines, fittings, apparatus and appliances for lighting, heating and motive power, and for all other purposes for which electricity can or may be used. Electric lines, fittings, apparatus and appliances so provided on consumers' premises, either before or after the passing of this Act, and any lands, buildings or works held by them in connection therewith to form part of the authorised undertaking.

Alteration of Type of Current, &c.—The Commissioners may require authorised undertakers to alter the type of current, frequency or pressure, but not of existing railway generating stations. There is a right of appeal to Ministry on ground of unreasonable expense.

Substitution of Special for Provisional Orders.—Anything which under the Electric Lighting Acts could be done by provisional order may be effected by a special Order made by Commissioners and confirmed by Ministry, or by an order establishing a joint authority. A special Order (under this section) must be laid before Parliament, and needs approval (with or without modification) by a resolution passed by each House.

Accounts, Statistics and Returns.—Joint authorities and authorised undertakers must furnish Electricity Commissioners with such accounts, statistics and returns as may be required.

Accounts of Joint Authorities.—Every joint electricity authority shall establish a fund, to which all receipts shall go, and out of which all payments shall be made. The authority must submit annual statement of income and expenditure on revenue account to the Commissioners. Accounts shall be audited as prescribed by Electricity Commissioners who shall appoint the auditor.

Electricity Commissioners must prepare an annual estimate of reciepts and expenditure and must apportion the debit balance amongst the joint authority and authorised undertakers in proportion to units generated in preceding year; and the assessments thall be paid to Commissioners, provided that the requisition for first two years shall be paid out of public funds, repayable (with interest) to the Treasury during the next three years. All receipts by Commissioners shall be paid into a separate fund, from which salaries and all expenses shall be paid.

Subscriptions to Associations.—Subject to consent of Electricity Commissioners, joint authorities and authorised undertakers may pay reasonable subscriptions to funds of associations promoting common interests, and any recognised association (not profit making) for developing the use of electricity.

Sec. 4 of the Conspiracy and Protection of Property Act, 1875, is made applicable to employees of joint authorities or authorised undertakers (thus making a breach of a contract endangering the supply of electricity a penal offence). Provision is also made for legalising agreements between joint authorities, undertakers and other parties.

The Commissioners may hold inquiries, require attendance of witnesses and take evidence on oath; also may make rules as to applications and other matters under this Act.

There are provisions for the application of the Act to Scotland and Ireland, the transfer of the powers of the Board of Trade to the Ministry of Transport, &c.

The Ministry of Transport proposes to issue an Order in Council fixing Jan. 23, 1920, as the date from which the powers and duties of the Board of Trade in relation to the Act will be transferred to the Minister of Transport.

Recent Papers on Electro-Chemistry.

At a recent meeting of the Faraday Society three Papers on matters of electro-chemical interest were read. We give accounts of these below.

An Aspect of Electrolytic Iron Deposition.

In a Paper on this subject, Lieut. W. A. Macfadyen, M.C., B.A., detailed experiments which were carried out to seek the best conditions for obtaining thick, hard, adherent deposits of iron on steel-mechanism parts which had been machined too much, or worn down in a few places, and thus rendered useless, so as to enable the scrapped parts to be replaced in use after treatment. A simple solution of ferrous ammonium sulphate in water was used as electrolyte, the only additions being sulphuric acid, and later, powdered charcoal. In the cold, the best deposits were obtained from concentrated solutions made about 0·005 Normal with respect to sulphuric acid, the current density being up to 23 amperes per square foot. From a solution saturated in the cold, heated to 65° C., and made about 0·02 Normal acid, excellent deposits were obtained at current densities of up to some 200 amperes per square foot, whilst metallic iron in rather less suitable form was deposited at the highest current density obtainable in the laboratory, namely, about 1,000 amperes per square foot. If iron be deposited direct on to a steel base and the whole subsequently annealed above the A_3 point for pure iron, the two become strongly welded together. Subsequent case-hardening is then usually advisable, since the annealed electrolytic iron is very soft.

The Electrolytic Formation of Perchlorate.

In a Paper on this subject by Mr. J. Guilfoyle Williams, B.Sc., it is pointed out that present practice in the electrolytic preparation of perchlorate uses much higher temperature of liquor, and current density, than is given in text-books. Experiments were given showing that the current efficiency of the electrolysis is not considerably affected by liquor temperatures up to 60° C. Production of 1 kilo $NaClO_4$ at this temperature requires only about 3 kw.-hours against about 3·6 kw.-hours for normal practice. During normal electrolysis the liquor is alkaline, owing to the presence of sodium hypochlorite; if this alkalinity is kept down by the frequent addition of hydrochloric acid, the current efficiency of high temperature electrolysis is improved.

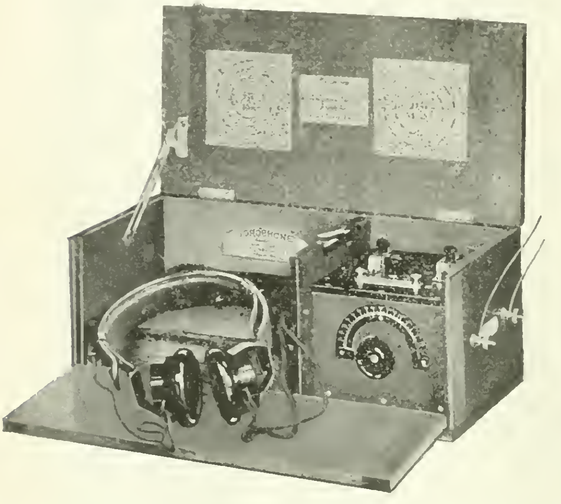
The Solution Theory of Steel and the Influence of Changes in Cubicle Concentration on the Electrical Resistivity.

Prof. E. D. Campbell showed that Baly's force-field theory is applied to the case of the solid solution of the non-ferrous elements in steel. The fundamental concept of this theory is that every molecule of a solute in solution possesses an electro-magnetic field. If the force-fields of any molecules are opened in solution these molecules become "active," and capable of reacting with different forms of energy—for example producing electrical conductance in an electric field. The resistivity of a solid solution, *e.g.*, steel, is dependent upon the concentration and degree of dissociation of the solutes. The experimental portion of the paper describes a research on the influence of the decarburisation by means of hydrogen of a series of alloy steels on the electrical resistivity, when the metal is in both the annealed and hardened condition. Annealed steels containing considerable amounts of chromium, tungsten and molybdenum show on decarburisation a marked increase in resistivity, due to the removal of the carbon from complex carbides and the dissolution of the metals in the iron. The measurements tabulated indicate marked differences in the constitution of the carbides in the various steels.

A New Type of Horophone.

We are accustomed to associate the name of Mr. Hope-Jones and the Synchronone Company, Ltd., with electric clocks, but they are also well known in the wireless world by the Horophone, which is a simple wireless receiving set very popular among watch and clock makers. This apparatus has now been remodelled to bring it up to date.

The new type of Horophone, which we illustrate herewith, makes use of "Variometer" tuning, thus dispensing altogether with inductances and sliders, and leaving but one adjustment necessary to receive the time signals transmitted from the Eiffel Tower at Paris. The necessary instruments are contained in a hard wood box, the double headgear telephones being in a compartment on the left. There is a switch on the underside of the lid so arranged that, on closing it, the aerial is connected to earth, thereby securing protection from lighting. On opening the box the programme of Paris time signals is revealed, together with their codes clearly represented by means of two spiral diagrams. The signals are transmitted at 10 o'clock and 10.49 in the morning and at 11.30 and 11.49 at night. It may not be generally known that this service has been carried out throughout the war Its accuracy is unquestioned. For those who have been caught by the lure of wireless and wish to listen to other transmitting stations and the shipping round our coasts a small addition is provided called a short-wave switch. But the object of the designers has been to avoid complications and to provide a simple instrument for the non-technical which will not readily get out of order, and will enable the Paris time signals to be easily heard on quite a small aerial.



The Latest Type of Horophone.

Joint Electricity Authority.

At the quarterly meeting of the Gloucestershire County Council last week it was agreed to co-operate in the formation of a joint electricity authority for an area embracing the whole of the county and part of the counties of Wilts and Monmouthshire, the cities of Bristol and Gloucester and the borough of Cheltenham, and probably Swindon. The vice-chairman (Lieut.-Col. R. J. Kerr) said the matter was of considerable importance to the county on account of there being within the county the electrical power station at the Government works at Beachley, and he believed the Ministry of Shipping had been for some time anxious to dispose of that station, either to a private company or other persons who were anxious to buy it. It was a matter of considerable importance that the station should be available for supplying electricity, particularly the Forest of Dean district. There were other schemes for the supply of electricity to the Forest of Dean mines and other possible consumers from Hereford. After referring to the recent conference at Bristol, the resolutions which were passed at that meeting were formally adopted.

The Somerset County Council have also passed resolutions expressing agreement with the formation of a joint electricity authority.

At a meeting of the Organising Committee of the preliminary authority for Bristol and the West of England, Mr. H. Faraday Proctor, engineer and manager of Bristol electricity department, was elected chairman.

Mr. J. Herbert Edwards, director of the Stroud Electric Supply Company and other companies, was present at the recent Bristol Conference, and is a member of the Drafting Committee.

Big French Electric Traction Scheme

A mission of French engineers has recently been visiting the United States in order to study modern methods of electric traction. The mission was sent by the Ministry of Public Works as a result of a scheme for the electrification of 5,220 miles of the permanent way of the Paris-Lyon-Mediterranee, the Paris-Orleans and the Midi Railway Companies. The high tension direct current system as employed on the Chicago, Milwaukee, and St. Paul Railway is recommended, and a member of the committee (M. Maudnit) states that, though some day the single-phase system will reach a satisfactory condition for a variety of combinations it has not yet arrived at that stage, and it is not so far advanced in America as in Europe. It is proposed to electrify 1,926 miles out of a total of 1,839 miles of the Paris-Orleans, 1,367 miles out of 6,040 miles of the P.L.M. and 1,926 out of 2,525 miles of the Midi.

In deciding upon the lines to be electrified the peculiarities of the various sections were taken into account. Both the Midi and the Paris-Orleans have many sections with heavy gradients and numerous tunnels; hence the greater necessity for the adoption of electric traction as early as possible, but the P.L.M. has more level lines with heavy traffic. The probable cost of the electrification, based on pre-war prices, was estimated at: Paris-Orleans, £16,500,000; P.L.M., £16,200,000; Midi, £29,500,000, or a total of £62,200,000. It was estimated, on the basis of the 1913 traffic, that electrification would save 1,500,000 metric tons of coal, and in the near future about 3,000,000 metric tons. The principal sources of the hydraulic power for the generating stations are set out in the report.

Housing and Transport.

In the course of an address to the members of the Auctioneers' and Estate Agents' Institute recently on "Some Aspects of the Housing Problem," Mr. Frank Hunt, chief valuer of the London County Council, dealt with the question of the transport facilities in the Greater London area and its relation to the housing problem. In his opinion, considerable improvements would be needed in the methods of transport, and the present lack of system, whereby there seemed to be no co-ordination in the use of the various instruments of transport for the purposes for which they were best adapted, would need to be superseded by an intelligent system. Obviously, the railways were better suited to the long-distance passenger, even in the suburban areas, whereas the bus and tramcar were suited to the shorter distance passenger.

He was sure that when the various instruments of transport in big towns were scientifically organised it would be found most convenient to run the trains to nodal stations, and to organise around those stations systems of surface transport. When the distance of, say, 6 miles was exceeded, the extra travel time on the train militated against its greater usefulness. The second relief which would apparently be needed was the electrification of the suburban lines. The capacity of a railway line depended not only on the number of roads, but the average speed for the journey, which was influenced very materially by the acceleration of the train from rest. Electrification had proved its utility in this respect. The first of the suburban lines in the London area to be electrified was the South London line of the London, Brighton & South Coast Railway, with the result that the traffic on the line was immediately doubled. The experience of the line in extending its usefulness had been repeated in the case of the London & South-Western Railway.

Legal Intelligence.

Hodges v. Webb.

The hearing of this action, in which plaintiff sought to restrain defendant from wrongfully interfering or attempting to interfere with his employment, was concluded on Tuesday.

For the plaintiff Mr. Tyler (Messrs. Tyler & Freeman) ,Mr. Banister, hon. secretary of the N.A.S.E., and others gave evidence. Mr. Banister said the N.A.S.E. was not formed with the intention of interfering in trade disputes, but it became a trade union in 1918, and since then it had power to take part in trade disputes. They had 17 hon. members, five of whom were contractors.

For the defence, Mr. Webb said that the first that he had heard of a dispute at Delectaland (where plaintiff was employed) was when a deputation came from the Watford branch to the London District Council. They made three complaints about the terms on which Messrs. Tyler & Freeman's men were employed. When he arrived at Delectaland on Oct. 13, he had a talk with the men before Hodges came down, and later he pointed out to plaintiff that the N.S.A.E. was not a recognised trade union, and he asked him whether he would not join the E.T.U. He refused; therefore he (witness) had no option but to call out the men. He simply pointed out that it would be beneficial to plaintiff to join the E.T.U. He denied saying that he would compel him to join the E.T.U., or that he would take away plaintiff's livelihood. If plaintiff had joined the E.T.U. there would have been no dispute.

In cross-examination he said a lot of men joined the E.T.U. during the war to avoid military service, and then fell out after the Armistice. The Watford men had raised the question of the outworking allowances.

After legal arguments his Lordship reserved judgment.

Commercial Topics.

Australian Imports and Exports.

The Federal Government has prohibited all imports from and exports to former enemy countries without the consent of the Commonwealth Minister of Customs.

It is announced that the revised conditions under which rubber-covered wire may be imported into Australia will not come into operation until the 1st April next.

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Electrical Supplies for Finland.

According to an American Consular report there is a demand in Finland for electrical plant and machinery, electric light fittings and supplies. It is also stated that there is a good market for automobile trucks of light weight and motor cycles. There is much undeveloped water power available in this country and in the course of time there should be a very good opening in this market for British electrical plant and apparatus.

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Trade Prospects in Czecho-Slovakia.

According to a correspondent in Czecho-Slovakia, there are good opportunities for British trade with that country. The new State is in urgent need of all kinds of raw materials and of a great number of manufactured goods. The country is fairly flourishing, and there are many opportunities for engineering work. Water-power is available in abundance, but up to the present very little has been utilised. In this direction great progress may be expected in the future. The Germans are reported to be exporting a considerable quantity of goods, especially all kinds of machinery and electrical appliances, and they furnish ample supplies to three large motor factories which are in full working order. The Czechs are exporting considerable quantities of Bohemian glass, part of it of the luxury order. British traders and manufacturers who wish to deal with Czecho-Slovakia must (it is stated) be prepared to trade according to the ways of the country. Commissions are far from being unknown, and they are not confined to the small firms.

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Japanese Commercial Developments.

According to recent reports, there is a great boom in Japanese commercial and industrial undertakings at present, but more particularly in all electric power and lighting machinery, mining, textile and manufacturing enterprises. Keen interest is also taken in the development of Manchurian industries. In order to keep pace with developments, increasing quantities of machinery have had to be imported, the total value of these imports up to August last being 61 million yen, compared with 37 million yen for the same period of 1918. Two-thirds of the imports came from America, and only one-sixth from Great Britain.

Although the imports of steam boilers increased somewhat in value, fuel economisers, tenders, locomotives, &c., were much in evidence; but imports of water turbines and penton wheels increased fairly largely. The total value up to July was 1,025,572 yen, an increase of 1,005,081 yen over last year, and of 891,857 yen on the same period of 1917. Dynamos, electric motors, transformers and others also registered a notable increase to 2,934,661 yen, against 1,472,502 yen for the same time last year. Metal and wood-working machinery recorded a gain of still greater importance, and by July the imports reached a value of 6,761,676 yen, against 3,625,333 yen for the same time last year, and 1,657,790 yen for the corresponding months of 1917. According to the "Board of Trade Journal," a considerable demand for Japanese goods has begun to flow in from Greece and Turkey of late, important firms exporting large quantities of goods direct to Constantinople and Smyrna. It is also stated that there is now a great demand from Bombay for Japanese sundry goods, most of which used to be imported from the United Kingdom.

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Engineering in China.

An interesting article by Prof. Middleton Smith on "The Future Relations of Great Britain and China" appears in the current issue of "Ways and Means." It is pointed out that in Hong Kong all the local interests have been booming for the past few years. They possess the unique combination of intelligent, reliable and cheap native labour and of supervision by British engineers. The Chinese themselves are beginning to take great interest in Western methods, and a very large number of students are studying applied science and modern industrial work. Our own manufacturing firms should consider carefully the enormous demand that is likely to take place for machinery in China. At present our most valuable exports to this country are piece goods. Cotton mills are springing up in the far east with astonishing rapidity. Our policy in order that we may get our share of this trade should be to co-operate with the Chinese and so obtain orders for engineering equipment in the new factories and workshops which are springing up in China. Hundreds of thousands of pounds worth of machinery and steel plates have been imported into Hong Kong dockyards during the last few years. Reinforced concrete is being largely used for building purposes with very cheap local cement, and this means a greater demand for imported steel bars. Fortunately, the British and Chinese are very good friends. There is good reason to be satisfied with the success of the efforts to promote amicable relations between the two races. It only remains to persuade the most conservative people on earth to utilise modern knowledge and Western experience, and there will follow an enormous boom in foreign trade. We hope electrical engineers in this country will do their best to bring about this desirable state of things.

Electricity Supply.

Harrogate Corporation has applied for sanction to loans of £4,500 for mains and services, and of £2,600 for transformers.

A sum of £75,000 is to be expended by the Stockport Electricity Committee on new plant and extensions of the mains.

Leith Dock Commissioners are putting in a new 1,500 kw. turbo-generator at the Albert Dock station to replace the existing gas driven engines.

A sub-committee has been appointed by Ayr Corporation to consider a proposal by the Electrical Engineer (Mr. R. Marshall) to put down additional generating plant at an estimated cost of £27,000.

St. Pancras Borough Council has asked the London County Council to sanction the borrowing of £89,209 for extensions of the electric supply undertaking, including £33,000 for a 5,000kw. turbine set.

Maidstone Corporation recently resolved to apply for sanction to borrow £32,000 to carry out extensions, including the supply of electrical energy to works at Snodland.

Owing to the inability of the Manchester Corporation to give an additional bulk supply the Salford Electricity Committee have decided to install another 5,000-kw. turbo-alternator as a stop-gap measure. This measure will be necessary to supply the increasing power requirements for the industries in the district.

The accounts of the Warrington electricity department for the year ended March 31 last show revenue £63,388 (compared with £50,334 in previous year), gross profit £14,993 (£14,429), and net profit £3,720 (£5,024). Costs, exclusive of capital charges, were 1·177d. (0·972d.) per unit sold. Units generated were 9,682,154 and sold 7,657,154. Maximum load was 4,219 kw. (3,882 kw.).

At a meeting of representatives of Nottingham, Leicester, Loughborough, Long Eaton, Ilkeston, Burton-on-Trent, Derby and Mansfield last week the question of the establishment of a super-electric power station on the banks of the River Trent or some other suitable site was further discussed. The consulting engineers, Mr. J. H. Rider and Mr. C. H. Wordingham, were present, but no definite decision was reached.

Experiments are being carried out by officials of H.M. Office of Works in regard to the lighting of the Chamber of the House of Commons, the Committee-rooms and the lobbies. For many years past the lighting of the Chamber has been carried out entirely by gas, with unsatisfactory results. In other parts of the Palace electric light is employed and it is probable that this form of illumination will be extended to the whole building.

The revenue of the St. Anne's-on-Sea electricity department for the year ended March 31, 1919, was £22,721 (compared with £21,220 in previous year), working expenses were £1,318 (£1,181), special charges £121 (£82), leaving gross profit of £3,732 (£3,713). Capital charges and war allowances required £5,149, and the net result was a deficit of £1,417. Units generated were 1,846,600 and sold 1,560,749 (1,896,486). Maximum simultaneous load was 750 kw.

Arbroath Town Council has made an arrangement with the local Electric Light and Power Company to supply current for public lighting at £16 per lamp per annum. The Council will take over the existing 20 pillars and fittings at £700, the pillars to be put into good working order and equipped with new lanterns and lamps and with lighting and switching gear by the company. The lamps will be of 1,000 c.p. from dark until 11 p.m., after which two lamps of 50 c.p. will be lighted on each post till dawn. For the period to Whitsunday 1920, the company will be paid £6 10s. per lamp.

The present position of the electric supply undertaking caused an animated discussion at the meeting of Hull City Council. A motion to call in an independent engineer to report upon the condition and capacity of the undertaking was rejected, but the electrical engineer was requested to prepare a full report on the matter. The remaining restrictions upon the supply to shopkeepers and kinema halls will be shortly relaxed, but no new supplies are to be afforded until further plant and larger supplies of suitable fuel are obtainable.

The Electricity Committee has instructed the City electrical engineer Major H. Bill) to prepare a report on the lighting of the main thoroughfares with electricity instead of gas. The Corporation purchases gas in bulk from the British Gas Light Company and distribute it in the Old Town. Arrangements have been made for the electric lighting of two thoroughfares, but a more extended scheme will probably have to wait until the electricity undertaking has been further extended.

The accounts of Redditch electricity department for the year ended March 31, 1919, show revenue £23,586 (compared with £20,610 in previous year) and working expenses £17,500 (£15,289). Interest required, £2,926 (£2,776) and repayment of loans £3,788 (£4,207), leaving a net deficit of £628. Working expenses were 1·57d. (1·35d.) and capital charges 0·62d. (0·63d.) per unit. Total maximum demand was 1410 kw. (1,246 kw.) load factor 21 (24·21) per cent. Units generated were 3,632,321 (3,792,286) and sold 2,597,206 (2,643,037).

The Barnsley Corporation has decided to carry out extensions of the electricity works at an estimated cost of £40,000, and also to erect a sub-station at Town End at £1,200. Councillor Foulstone (Chairman of the Committee) estimates that the production of electric current during the present year will be 3,600,000 units, at an average coal consumption of 4·2 lb. per unit, which represents a considerable economy in coal consumption. There would also be economies in the use of water, oil, labour, &c. Two large consumers were waiting to be supplied with power, and the department was able to prove to these firms that the use of electricity would effect a saving of 75 per cent. as compared with coal.

Councillor W. Greenwood, one of Oldham's leading cotton manufacturers, gives it as his opinion that for financial and health reasons, Oldham should adopt electrical driving. The worst local feature is its smoke, and he claims that the town has the biggest consumption of power of almost any area in the world. If Oldham grouped that power into one or two big generating stations the town would be enormously improved in the next 25 years. He is sure electrical driving in mills would go forward in a short time. The firm of which Councillor Greenwood is managing director are the biggest consumers of electrical energy from the Corporation. They take 3,000 h.p. for their mills, but in addition they obtain 2,300 h.p. from steam engines, and although steam is at present the cheaper of the two, he thinks electricity is bound to be the cheaper in future providing the Corporation take up the question in a practical manner.

An interesting experiment which has been carried out for over a year by the Glasgow Electricity Department was described in a recent lecture by Councillor Denny to the Women's Educational Class of the Independent Labour Party. Two houses, each of three apartments, in different parts of the city occupied by working-class people were equipped with electrical lighting, heating, and domestic plant, and for more than a year electricity was used in each house for domestic purposes. The cost in one case was £35 per annum, and in the other £32 a year. No coal or gas was used in either house. In both cases the grates were adapted for electric heating, which gave every satisfaction to the tenants. Electric cooking showed a saving in comparison with other methods. Ironing and carpet sweeping were also conducted with the aid of electric power, and women in both houses agreed that the use of electricity saved labour and promoted health and cleanliness.

Stafford Council recently applied for sanction to a loan of £30,000 for a 1,000 kw. set and other works, but the application has now been amended so as to enable the Council to borrow a sum not exceeding £65,000 for the purchase of two generating sets of about 1,250 kw. each, with foundations, two water-tube boilers, one rotary converter, h.t. and l.t. switchgear, transformers, &c. Ald. Westhead, chairman of the Gas and Electricity Committee, stated that the demand for electricity was going up by leaps and bounds, and it was estimated that during the next two years they would require the two generating sets. They had been guided by the advice of their consulting engineer (Mr. Pearce), who had confirmed the estimate of the electrical engineer and manager (Mr. Robins). The salvation of the concern lay in increased output, because an undertaking of that kind could not stand still. The demands for electricity, which were very numerous, included several important applications for power, which paid better than lighting.

In a report by the Belfast City Electrical Engineer (Mr. T. W. Bloxam) it is stated that as the period of maximum load on the station might now be considered past, a comparison might be made with the corresponding nine months ending Dec. 31, 1918. The maximum simultaneous load arising from the systems of supply was 14,269 k.w., an increase of over 43 per cent. over 1918, and the total number of units sold was over 20,000,000, an increase of over 44 per cent. Of that nearly 13,000,000 were sold for power and light, including 5½ millions supplied to the shipyards. In addition, 7½ millions were supplied to the tramways, an increase of 8 per cent. The total coal used was 46,322 tons, an increase of 38 per cent., although the total units generated had increased by 46 per cent. The coal used per unit generated had been reduced by 5¾ per cent., and the lowest figure yet recorded was reached September (3·77 lbs.). The whole of the plant (18 engines, 22 boilers, with three different systems of supply interconnected) was operated simultaneously during the winter. Credit was due to the staff for having succeeded in maintaining the supply with comparatively minor interruptions.

In order to assist in the development of the industrial and commercial resources of Sheffield the Development Department of the Corporation has issued a pamphlet on the Power Facilities of the City. The publication states that "nearness and cheapness of fuel have placed the city ahead of her rivals, while the resources of her engineering sons have given to her the ability to compete successfully with all-comers. Progress has been rapid, but with all our vaunted advance we are compelled to admit that we are barely on the threashold of the new epoch—that of electricity. Yet in its realisation of the responsibilities of a great City Corporation, Sheffield has not failed to make pace in the supply of electrical power." The history of the municipal control of the electricity undertaking and figures to show its phenomenal growth are given. At present the capacity of the generating plant in operation at the three power stations is over 90,000 h.p., but when the new station and other schemes which have been arranged are completed the city's supply will be over 200,000 h.p. This will be equal to providing an output of over 600,000,000 units per annum. In the autumn of 1919 about 5,000 electric motors, of a total of 120,000 h.p., were in daily use.

The emeregncy power station at Blackburn Meadows is to be completed this year, and the additional power which the station will provide is urgently needed at present. Among other work to be undertaken is a large amount of main extensions. The whole of the non-industrial areas of Sheffield have suffered for want of mains for five years. Very heavy tramway main extensions are required to deal with the extra cars which have been put into use. The laying down of cables and the installation of lighting for the 1,500 new houses will also require to be undertaken. Of the four district schemes three have been passed, and the specification for the fourth is being prepared.

Electric Traction.

The Ministry of Transport has authorised an increase of 50 per cent. in the Leith Tramway fares.

Exeter Corporation is seeking authority to raise a loan of £7,154 for the purchase of electric refuse-collection vehicles.

In a report by the Medical Officer of Health for Willesden, it is stated that the electric vehicles employed in the removal of house refuse have worked satisfactorily.

A meeting of Lytham electors has passed a resolution approving of application to Parliament for a Bill to empower the Council to acquire the tramways in Lytham area, to run omnibuses, &c.

The Minister of Transport has confirmed the Nottingham-Colwick Estates Light Railway Order, 1919, authorising the construction of a Light Railway in the Parish of Colwick and Rural District of Basford,

Owing to dissatisfaction with the present system of payment for overtime and meal-time duties the Bury (Lancs.) tramway employees have intimated to the management that they will not work any more overtime until certain overtime rates are paid.

The accounts of the Wallasey Tramways undertaking for the year ended March 31 show revenue £100,078 (against £82,562 in previous year) and gross profit £30,208 (£28,164), and after providing for interest, sinking fund and instalment of loans, there remained £12,000 to transfer to district fund in aid of rates. Total revenue per car mile was 18·86d.; working expenses (including power) were 10·17d.; passengers carried 19,354,654 (17,111,453) and car miles run 1,273,333 (1,284,647).

The Salford Tramways Department accounts for the year ended March 31 show revenue £425,383 (compared with £350,101 in the previous year), gross profit £130,882 (£110,332), and net profit £42,672 (£26,970), of which £25,000 (£16,970) has been contributed to relief of rates, and the remainder placed to reserve. Total revenue per car mile was 19·159d., and working expenses were 11·853d. Passengers carried were 70,433,126(65,061,878), car miles run 5,479,958 (5,595,633) and units used 10,666,672.

Imperial and Foreign Notes.

Colac (Victoria) Council has decided to obtain a report upon a proposal to adopt electric lighting for the town.

Rockhampton (Queensland) recently received a report upon the electric lighting of the town from Mr. J. Just, who says the city is eminently suited for an electricity supply and tramway scheme.

According to Mr. D. B. Hanna, general manager of the Canadian Government Railways, the electrification of all railway termini in Canada will be carried out within a comparatively short time.

Considerable expenditure is to be incurred in improving the telephone and telegraph systems of the Federated Malay States. A trunk telephone line is to be laid between Perak and Selangor, and much material will be required.

The Melbourne Metropolitan Tramways Act amalgamated the control of all systems, excepting the Brighton-St. Kilda and Sandringham-Black Rock lines as from November last. One of the first questions to be dealt with by the new Tramways Board is the extension of tramways which are being sought in many suburbs. The proposed line between the city and West Brunswick will receive immediate consideration by the Board. The cable system has been taken over, but the board has six months for taking over the electric lines.

The Tasmanian Premier recently announced as the result of a conference between Tasmanian State Ministers and the directors and officers of the Read Rosebery Mining Company an agreement had been arrived at in regard to certain tentative proposals which the representatives of the company were to submit to the directors. The tentative agreement is to cover the supply of 15,000 h.p. of electrical energy to the company at Zeeban, power to be supplied from the Lake Ralston scheme if further investigations confirmed the data already obtained that the 15,000 h.p. for the Read Rosebery Company, plus power for the demands of Zeehan and other mining requirements, could be met by this scheme.

It is reported that there is a great need in Athens of electrical fittings and supplies for electric lighting.

At an extraordinary meeting of the Volta Electric Company, Ltd., Stockholm, it was decided to liquidate the company and a resolution for reconstruction was provisionally accepted. The Volta Company will be taken over by a new company with a capital of Kr.6,500,000.

A project for the construction of a normal gauge railway from the French frontier right across Spain to Algeciras is under consideration by the Government. The line will be connected by ferry boats via Tangier with the French line from Tangier to Dakar, and will be operated electrically, the water-power of the Pyrenees being used to supply current.

A Bill is to be introduced into the French Chamber of Deputies by the Minister of Public Works in order to provide for the Improvement of the Rhine. The proposed improvements will comprise the creation of a canal 125 km. long from Huningue to Strasbourg, and the construction of a large river port at the latter town. It is also intended to build 10 hydro-electric stations which will have a total capacity of 700,000 h.p., in order to supply electrical energy to Paris and the northern and eastern regions of France. The total cost is estimated at about 1,000 million francs.

Institution Notes.

The Institution of Electrical Engineers.—The Scottish Centre will hold a conversazione on Feb. 4. This function will mark the beginning of the resumption of social intercourse of the centre which was suspended during the war.

Members of the Institution of Electrical Engineers wishing to attend the Conversazione of the Scottish Centre on Feb. 4, are reminded that they should apply for tickets before Wednesday, Jan. 28. These may be obtained from Mr. A. Lindsay, 173, Bath-street, Glasgow, or from Mr. J. Taylor, 153, West George-street, Glasgow.

We have received a programme of the meetings of the Institute of Metals in London and of the local sections at Birmingham, Glasgow, and Sheffield, which will be held during the 1920 session. We understand that the membership of the Institute is now over 1,200, and that applications are still being received.

At the monthly meeting of the Yorkshire branch of the Association of Mining Electrical Engineers, which took place at Leeds last week, a paper by Mr. Idris Jones on " Practical Mining Electrical Notes " was read by the President, and had particular reference to points arising from the use of e.h.t. alternating current systems in collieries.

The Industrial League and Council has organised a series of lectures to be given in the Conference Hall of the Central Hall, Westminster. These will include Mr. J. F. Butterworth on " Modern Methods in Industry " ; Major E. A. Pells on " Conditions the Workers May Control " ; Mr. W. J. Grosart on " Evolution of Modern Methods in Industry " ; Mr. H. Atkinson on " Economical Production and Prevention of Waste " ; Mr. F. C. Laurence on " The Effect of Modern Industrial Methods on Employment and Wages "; and Mr. F. J. Butterworth on " Results Achieved in Industry by Modern Methods." Anyone desirous of attending the conferences can obtain full particulars from the Secretary to the Industrial League and Council.

The memorandum for 1918-19 of Mr. C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association, deals somewhat fully with the important question of coal economy. He draws attention to recent statements about factory owners wastefully burning as much as 7lb. of coal per i.h.p., although with good practice 2lb. should suffice. In reality these so-called wasteful works consume relatively very little fuel for power, only about one-third pound per horse power, because they do not condense or blow away their waste steam, but utilise it for heating and boiling purposes. It is suggested that wherever two works are situated not too far apart, the one requiring much power, the other much steam for boiling, they could with advantage combine their steam requirements, and thus be able to reduce their joint coal bill by one half.

As on previous occasions Mr. Stromeyer pays marked attention to the safety of boilers, and this year draws some very useful lessons from Board of Trade reports on boiler explosions, which now number nearly 2,500. In this year's memorandum the causes of economiser explosions are firstly dealt with, and the Commissioners' finding in a recent explosion is strongly controverted. Donkey boiler explosions are then summarised, and the interesting discovery is recorded that a well-established belief amongst engineers about cross tubes being a source of strength to these boilers is wrong.

Miscellaneous.

We are asked to state that the article on " Wire Ropes," by A.C.N., which appeared on page 681 of our Materials Handling Issue, Dec. 12. 1919, was contributed by Messrs. J. & E. Wright, Ltd., Birmingham.

The Sloan Electrical Company inform us that, acting upon instructions from Messrs. Philips' Glowlampworks, of Eindhoven, Holland, they have forwarded to the Organising Secretary of the Ramsay Memorial Fund, a cheque value £500 as a donation towards the fund.

Engineers, contractors and others who are interested in the end of the war will be glad to learn that the Government are legally advised that the statutory date of the end of the war is that on which the Peace Treaty with the last of the enemy Powers comes into operation. Treaties have still to be ratified with Austria-Hungary and Bulgaria, while the Turkish Treaty has not yet been presented.

In our account of the discussion which took place at Glasgow on Captain J. M. Scott Maxwell's paper on " Scientific Management," which appeared on page 15 of our issue of January 2, Capt. Maxwell is reported to have said that " the B.E.A.M.A. were practically debarred from taking up the question, as the Federation of British Industries held that labour and wages question were their preserve." This should have read " Employers' Federation " and not the " Federation of British Industries."

On Monday a Lock-out of Electricians was declared by Liverpool electrical contractors. The National Federated Electrical Association adopted this course in consequence of the action taken by the Electrical Trades Union in withdrawing their members from certain firms in the Association owing to the non-ratification of the new rules by the National Joint Industrial Council. The new working rules had been agreed by the District Industrial Council, but had not been ratified by the National Council, who put forward amendments. The Union admits the National Council's right to veto, but, as they had not done so, claims that the rules should be in operation. A number of men ceased work last week-end to enforce recognition of the new rules, and the employers responded by a lock-out. Some 400 men have ceased work in Liverpool and district.

Tenders Invited and Accepted.

Edinburgh Corporation invite tenders (by Feb. 9) for an overhead travelling crane.

Tenders are required by Feb. 7 for wiring the Cheltenham General Hospital for electric lighting. Specifications from the Secretary.

Colne Corporation invite tenders for a new or second-hand turbo-alternator (1,250–2,000 kw.). Offers to Borough Electrical Engineer.

Bradford Corporation want tenders by Jan. 28 for supply of two electric battery locomotives. Particulars from Mr. J. Garfield, Esholt Hall, Shipley.

Whitby Council want tenders by Jan. 30 for turbo-alternator, condenser, pumps, water-tube boiler, rotary converter, transformer, a.c. switchboard and e.h.t. cables.

York Electricity Committee require tenders by noon, Jan. 30, for carrying out a hydro-electric scheme at Lenton Lock. Specifications from the Electrical Engineer and Manager.

Greenock Corporation require tenders by Feb. 3 for electrical installation work in 114 semi-detached houses. Schedules may be obtained at the Office of Public Works, Municipal-buildings, Greenock.

Bray (Ireland) Council require tenders by 8 p.m. Jan. 30 for 200 b.h.p. Diesel engine, direct coupled to 135 k.v.a. single-phase alternator and exciter. Specification from the Electrical Engineer.

Aberdeen Electrical Committee require tenders for two water-tube boilers, superheaters, economisers, &c. Specifications from the City Electrical Engineer, Mr. J. Alex. Bell, and tenders by noon Jan. 31.

The Victorian Government Railway Commissioners require tenders by Feb. 26 for incandescent electric lamps (contract 32,894). Forms of tender from the Secretary, Railway Offices, Melbourne.

West Ham Corporation require tenders by 4 p.m. Feb. 24 for erection and supply of a refuse destructor and steam-raising plant Specifications from the Borough Engineer.

Wallasey Corporation require tenders by Jan. 31 for a 5,000 kw. three-phase turbo-alternator, water-tube boiler, economiser, feed pump, 500 kw. rotary converter and e.h.t. switchgear. Specifications from the Borough Electrical Engineer.

Hampstead (London) Council require tenders by 4 p.m. Jan. 29 fo one year's supply of electrical engineer's stores, ironmongery, &c., and 6 or 12 months' supply of oils to the electricity works. Forms of tender, &c., from the Town Clerk.

Pontypridd Urban Council invite tenders for the supply and erection of a rotary converter, transformer and switchgear. Specifications from the engineer, Mr. J. E. Teasdel, and tenders to the clerk, Mr. H. Leonard Porcher, Municipal-buildings, Pontypridd, by noon Jan. 30.

Ilford Urban Council invite tenders for the supply of 1,000 kw. of converting plant, cooling tower, motor-driven air compressor and l.t. cables. Specifications from the engineer, Mr. A. H. Shaw, and tenders to the clerk (Mr. Adam Partington), Town Hall, Ilford, by Jan. 27.

Aldershot Urban Council invite tenders for geared turbine and generator, condensing plant, circulating and other pumps, water-tube boiler and super-heater, and armoured, lead-covered, paper-insulated feeder and pilot cables. Particulars from the electrical engineer, Mr. F. Garside, and tenders to the clerk to the council, Mr. D. Llewellyn Griffiths, Municipal-buildings, Grosvenor-road, Aldershot, by Feb. 17.

Littleborough Urban Council has accepted the tender of W. T. Henley's Telegraph Works Company for the supply of electric cables.

Colne Tramways Committee have ordered two additional tramcars from Messrs. Dick, Kerr & Company.

Ipswich Corporation recently placed an order for a 3,000-kw. Ljungstrom turbo-alternator with the Brush Electrical Engineering Company, at £24,675.

The tender for the extensions to the water-cooling towers at Accrington electricity works submitted by Messrs. Peter Brotherhood, Ltd., at £2,500, being the lowest, has been accepted.

The Metropolitan Asylums Board has entered into further agreements with the Tudor Accumulator Company for the maintenance for a year of the electric batteries of two vehicles at a cost of $2\frac{1}{4}$d. per mile run.

Bolton Corporation recently accepted the tender of the Metropolitan-Vickers Electrical Company for e.h.t. switchgear and for a 12,000-wk alternator. Messrs. Escher, Wyss & Company will supply the turbine.

In connection with the installation by the Birmingham Electric Supply Committee of a storage battery at the Water-street power station the following tenders have been accepted : Tudor Accumulator Company, battery, £53,488 ; English Electric Company, boosters, £9,002 ; Bertam Thanes, switchgear, £1,676 ; Callender's Cable & Construction Company, cable, £3,772.

We learn from the Department of Overseas Trade that the Auckland (N.Z.) City Council has recently placed the following contracts for electrical material :—

Messrs. A. & T. Burt, Ltd. (manufacturers, Siemens Bros. & Co.), h.t. and l.t. cable, £21,644 ; Messrs. A. D. Riley & Company (manufacturers, Western Electric Company), triple braided overhead cable, £7,844 ; Messrs. Richardson, McCabe & Company (manufacturers, Callender's Cable and Construction Company), rubber cable, £2,227 ; National Electric and Engineering Company (manufacturers, General Electric Company, U.S.A.), transformers, switchgear and oil filter, £4,056 10s. ; Redpath & Sons, 980 ironbark dressed poles, £2,760, and 3,250 straight stem insulators and 800 shackles, £485.

Educational.

In the faculty of engineering of the University of Liverpool full courses of instruction are provided in civil, electrical and mechanical and marine engineering, naval architecture, physics, mathematics, chemistry, &c. The Lent term commenced on the 8th inst. Prospectuses of the faculty may be obtained from the Registrar.

An appeal is being made for raising £100,000 to erect new ENGINEERING LABORATORIES for the University of London at University College. The appeal states that the School of Engineering was established in 1828, and it has numbered among its pupils many distinguished engineers. The present buildings date from 1893, and there has been no reconstruction since, though the need of enlargement is great and the advance of engineering science has outrun much of the equipment. Space is available for extensions. Plans have been drawn for two additional floors, with the reconstruction of part of the south wing in such a way as to provide more lecture room and accommodation for the various departments. A hydraulic laboratory, suited to modern requirements is also proposed, and the members of the family of the late Mr. Charles Hawksley are contributing £3,000 for the laboratory, with which it is intended Mr. Hawksley's name shall be associated.

Various branches of engineering are taught at University College. All make heavy demands. The need of extension, which, before the war, was badly felt, has now become more urgent than ever, owing to the increase in the number of students which has followed demobilisation. It is pointed out that the way of the student of engineering must be made easier in the general interest, and the only method of doing so is to combine theoretical training with a certain amount of technical education. An engineering laboratory must contain experimental engines (steam and internal combustion) by which the student can learn to account for every thermal unit that comes out of coal or oil fuel; and there must be opportunity for hydraulic experiments. The very size of London, its distances, the removal of great engineering firms from the banks of the Thames are all substantial arguments for a fully-organised engineering school. A boy in a city like Glasgow has practical facilities on every side; for the London boy they must be concentrated in one spot, since he cannot be always running from end to end of the town to study them—even when they are there to be studied. After a reference to the work of engineers in the war it is claimed that engineering has earned an endowment by its war work.

The President of the Equipment and Endowment Fund Committee is Prince Arthur of Connaught, and the Chairman of the Engineering Appeal Committee is Sir Alex. B. W. Kennedy; the treasurer is Sir Ernest Moir, Bt.; and the honorary secretaries are Prof. H. R. J. Burstall and Dr. W. W. Seton. Lord Cowdray has given £10,000 to the fund, with a promise of another £10,000 when the total reaches £70,000. Donations or promises may be sent to Prince Arthur of Connaught, 42, Upper Grosvenor-street, W.1, or to Sir Ernest Moir at University College, Gower-street, London, W.C.

Personal and Appointments.

The Right Hon. Sir Albert Henry Stanley, who was recently created a Baron, has taken the title of Baron Ashfield, of Southwell, in the county of Nottingham.

Mr. E. R. Myers has been appointed overhead lines superintendent of the Liverpool Corporation tramways department.

Wigan Corporation officials, through the Mayor, have presented a case of cutlery to Mr. F. Buckley, former tramways manager at Wigan, who was recently appointed to a similar post at Bury.

On the invitation of the Council of the Senate of Cambridge University, the Chancellor, the Vice-Chancellor, Mr. Rawlinson, M.P., Prof. Sir J. Larmor, M.P., Prof. Sir J. J. Thomson, Dr. Hobson and Prof. Sir Ernest Rutherford will serve as representatives of the University on a joint committee of the Royal Society and the University for taking steps to secure an appropriate memorial to the late Lord Rayleigh.

Prof. Pierce Purcell, who was Secretary of the Irish Peat Inquiry Committee, has been appointed to act as Peat Investigation Officer under the Fuel Research Board. The duties of the Peat Investigation Officer will be to keep the Board informed of all progress in connection with research into the utilisation of peat, to continue and extend experiments on the mechanical cutting and winning of peat, and also to make arrangements for careful tests of the use of peat as a fuel under boilers.

Owing to the recent resignation of Mr. Jeken as first assistant electrical engineer of Leeds Corporation tramway department, it is proposed to promote Mr. J. S. Hamilton, D.S.O., to the post, at £500 per annum. Mr. J. Burbridge becomes second assistant engineer at £350 per annum; Mr. A. N. Daggett has been appointed repair assistant in the car works at £250 per annum. In the electricity department Mr. H. Smithson succeeds Mr. Bacon as installation engineer.

The Lord President of the Council has approved the appointment of Col. Sir Frederic Nathan, K.B.E., late R.A., to be power alcohol investigation officer under the Fuel Research Board of the Department of Scientific and Industrial Research. The appointment has been made as a result of the consideration given by the Committee of Council for Scientific and Industrial Research to report of the Inter-departmental Committee on the Production and Utilisation of Alcohol for Power and Traction Purposes. The Fuel Research Board propose to begin by bringing the work already being done both as regards production and utilisation of alcohol into proper focus.

Catalogues, Price Lists, &c.

From the D. P. Battery Company, Ltd., we have received an artistic coloured calender with monthly tear-off slips.

We have received from Messrs. S. G. Leach & Company, Ltd., of Artillery-lane, London, E.C., a coloured calendar representing an electric fan and having "windows" to show the days and dates, which are printed on revolving discs.

Well illustrated pamphlets in Spanish, dealing with their small electric motors for sewing machines, &c., and with motor generators and electric welding plant equipment have been issued by the Westinghouse Electric International Company, of East Pittsburgh, Pa.

In leaflet No. 103 of the Credenda Conduits Company, Ltd., particulars and prices are given of the "Creda" electric toasters, water boilers, sterilizers for surgical instruments and steel utensils. Another leaflet is devoted to the "Creda" pedestal fire which was recently described in The Electrician.

We have received copies of the first issue of (1) the Bradford Chamber of Commerce Year Book and (2) the Official Handbook of the Batley and Borstall, Cleckheaton, Dewsbury, Heckmondwike, Keighley, Ossett and Wakefield Chambers of Commerce, published by the Bemrose Publicity Company, Ltd., 25, Midland-place, Derby, and 133, High Holborn, London, W.C. 1. Both books contain a trade index in English, French, Russian, and Spanish, with the addition of Italian in the latter case.

The design and construction of the Siemens ringing vibrator (pole changer) are described and illustrated in a pamphlet recently issued by Messrs Siemens Brothers & Company, Ltd. The instrument, which will supply ringing current for small or medium-sized telephone exchanges, reduces and accelerates the work of operating. The apparatus consists of a device for converting a battery current into a suitable current for ringing magneto telephone bells, thus enabling an operator to call stations by pressing a key. The terminals are so arranged that connections to line and battery can be made without opening the instrument.

The Lea Recorder Company, Ltd., of 28, Deansgate, Manchester, has issued a pamphlet which gives particulars of the "Lea" recorder, and also some users' comments on its working and value. Many of these testimonials are from supply-station engineers who have used the instrument, and they all speak in high terms of its efficiency and accuracy. In these days it is essential that engineers should be able to check the steam consumption and efficiency of their plant, and this can be done by means of the "Lea" recorder. Accompanying the pamphlet is a diagram which shows the lbs. of water evaporated per lb. of coal burnt at boiler pressure, from feed water at 100° F., and at a glance the heat efficiency of a boiler when the evaporation per lb. of coal is known may be ascertained.

An attractive 36 page booklet on the "Westinghouse" Underfeed stoker has reached us from the Westinghouse Electric and Mfg. Company, E. Pittsburgh, Pa. Under the head of "Details of Construction," it gives the leading features of design of the machine, and the interconnection of grates and tuyeres and the arrangement of brackets, gears and fuel deflecting plates are clearly described. By the use of sectional diagrams and charts, the distinctive features of the Westinghouse zone system of air distribution is explained, while the subjects of "Efficiency," "Capacity" and "Flexibility" are amply treated, and numerous curves of performance data are included. Under the subjects of "The Coal Saving Problem" and "Fuel Burning-Equipment of Modern Power Stations," interesting and instructive information is given for those who have the operation of stokers in charge. A long list of representative users of these stokers is added.

Messrs. M. B. Wild & Company, Ltd., of Nechells, Birmingham, have issued a handsome catalogue of winding, hauling and pumping machinery. The publication runs to 64 pages, and is clearly printed and beautifully illustrated. The firm have a long and extensive experience in the manufacture of mining plant, and each machine described in the publication has been specially designed and manufactured in the works. Electric and other machines are included in the new catalogue, the first section of which gives particulars of winding gear and an illustrated description of the "Exhall" overwind preventer. Haulage gears of various types, sizes and capacities, winches, capstans, gear parts, &c., are next described, while the third section is devoted to electric, steam and air pumps, and the catalogue concludes with miscellaneous machinery, presses, &c. Some notes, tables and engineering data are included and add to the utility of the publication.

A number of well-got-up pamphlets and leaflets relating to the use of electricity in the home have just been issued by the Electrical Development Association. They are fully illustrated and cover nearly every application of electricity to household and domestic purposes. If these publications are distributed in a proper manner they should have a marked effect upon the demand for electric current for lighting, heating and cooking, as well as for cleaning and labour-saving appliances. The pamphlet on "Fuel Waste and the Remedy" shows clearly what a unit of electricity will do; another pamphlet demonstrates how electricity can solve the servant problem and allay domestic unrest; while a third relates to electric service for shops and business premises. Three other pamphlets are devoted to the electrical equipment of the house, and bring out very clearly the convenience, the cleanliness and other comforts to be obtained from the use of electricity for lighting, cooking and heating. Copies of the pamphlets and electros of the various illustrations used may be obtained by electric supply undertakings, manufacturers and contractors on application to the Secretary and Director of the Association at Hampden House, 84, Kingsway, London, W.C.2.

Business Items, &c.

Messrs. Pritchett & Gold and Electrical Power Storage Company, Ltd., have removed to more commodious premises at 50, Grosvenor-gardens, Victoria, London, S.W.1.

The London offices of Messrs. Marshall, Sons & Company have been removed to 3, London Wall-buildings, E.C. 2. Telegrams: Engine Ave London; telephone, London Wall 1667.

Messrs. Armstrong, Whitworth & Company have entered into an agreement with Messrs. Sulzer Brothers by which they acquire a license to manufacture and sell in Great Britain and the colonies, two cycle marine oil engines.

We are informed that the "A.W.P." electrodes for arc welding have been approved by Lloyds Register of Shipping for use in ship construction, and by the British Corporation for the Survey and Registry of Shipping.

The Stanton Ironworks Company, Ltd., near Nottingham, have purchased, as from 1st inst., the ironworks, foundries and ironstone properties of Messrs. James Oakes & Company, excluding, however, the collieries and clay works.

Messrs. Peto & Radford, makers of the well-known "P & R" accumulators, have removed their London headquarters from 12, Heddon-street, W.1, to 50, Grosvenor-gardens, S.W.1. Telephone number is Victoria 3667, and the telegraphic address is "Concentration Sowest, London."

The Board of Trade announce that the Scientific Instruments, Glassware and Potash Production Branch, the Mineral Resources Development and the Controller of Trading Accounts have now removed to the new public Offices, Great George-street, S.W.1. (Telephone No. Victoria 9,800).

Mr. J. C. Elvy, A.M.I.E.E., M.I.E.Soc., who resigned from the Saint Pancras Borough Electricity Supply and entered His Majesty's Forces, being attached to the Headquarters Staff of R.A.F. Technical Branch, was demobbed in August last, and he has now been appointed Electrical Engineer to arrange for the equipment of a large Film Producing Studio, involving a generating plant of some 1,000kw. This appointment does not preclude him from taking up other consulting work.

Appointments Vacant.

An assistant master is required for H.M. Dockyard Schools. Applications to the Secretary of the Admiralty, Whitehall, London, S.W. 1.

An assistant lecturer in physics is required at the City of Bradford Technical College, salary £150 to £350, with bonus of £78. Further particulars from the principal.

A charge shift engineer is required at the Greenwich generating station of the London County Council. Salary £250—£10—£300 a year subject to war bonus of 20 per cent.+£90. Applications to the Clerk of the Council, County Hall, Spring-gardens, S.W.1, by 4 p.m., Feb. 2.

Cardiff Tramways and Electric Lighting Committee have received 84 applications for the post of electrical engineer and 44 for that of tramways manager. Mr. Arthur Ellis, who has now retired, held both positions. The applications have been referred to a sub-committee.

Liquidations and Bankruptcies.

Claims against the Holme Electric Company, Ltd. (in vol. liq.) are to be sent by Feb. 10 to Mr. Alderson, Holme, nr. Holmfirth, Huddersfield.

Claims against the Blackpool & Fleetwood Tramroad Company (in vol. liq.) are to be sent by Jan. 31 to the secretary, Mr. John Cameron, 75, Red Bank-road, Bispham-with-Norbreck, near Blackpool.

Notice is given of intention to pay a dividend to non-enemy creditors of the A.E.G. Electrical Company of South Africa, Ltd., and claims are to be sent to the liquidator, Mr. H. de Vaux Brougham, 33, Carey-street, London, W.C., by Feb. 2.

Walter Hy. Mellon, electrical engineer, lately trading as H. B. Wallis & Company at 43, Turnham Green-terrace, Chiswick, has been adjudicated bankrupt. First meeting of creditors on Feb. 5 at 14, Bedford-row, London, W.C., and the public examination on Feb. 24 at Brentford Court House.

The discharge of Cecil Hellyar (trading in partnership with another as A. Parker & Co.), electrical engineer, lately trading at 130, Upper Richmond-road, London, S.W., has been granted subject to debtor's consent to adjournment for £50 (which has been paid to the official receiver).

Obituary.

The death took place on the 2nd inst., at Larbert, Dunedin, New Zealand, of Mr. Alexander Burt, founder and managing director of A. & T. Burt, Ltd., electrical and mechanical engineers, of New Zealand. Deceased was 80 years of age.

The death is announced of Major-General Sir P. G. Twining, K.C.M.G., C.B., M.V.O., Director of Fortifications and Works at the War Office. He served in the Royal Engineers in India, Canada, Africa and China. In September, 1914, he went to France as commandant, Royal Engineers, Meerut Division, and afterwards received a staff appointment. He was promoted colonel in 1915, and in 1917 became major-general. He accomplished very valuable work in France as Deputy Director-General of Transportation, and in April, 1918, he was appointed Director of Fortifications and Works. He was well known to many civil engineers.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged. at the Patent Office the former is given in brackets after the title.

1917 Specification.

135,225 Bellaviti. Apparatus for heating liquids electrically. (2/11/17.)

1918 Specifications.

120,570 Cockaday. Radio-telegraphy. (27/10/17.)

An apparatus including a power circuit (preferably a direct-current supply circuit having therein the primary coil of an initial step-up transformer, and a spark discharge or oscillating circuit supplied from the secondary coil of said transformer, and comprising a condenser and also the primary coil of an oscillation transformer, in combination with a device for successively making and breaking the power circuit so that a pulsating current of high frequency will be set up in the primary coil of the initial transformer, and a timing spark-gap device, across which the sparking can take place only at a time when the power circuit is broken.

121,942 Splitdorf Electrical Co. Magneto-electric ignition mechanism for internal-combustion engines. (2/1/18.)
122,814 Seimbille. Electric water-heater. (28/1/18.)
128,186 Holslag. Electric arc welding and repairing. (11/6/18.)
133,013 Holslag. Alternating current electric arc cutting and welding apparatus. (21/9/18.)
135,237 Morgan Crucible Co. & Speirs. Current-regulating devices for electrically heated crucibles, retorts, muffles, melting furnaces and the like. (12/10/18.)
135,238 Woodburn. Electric welding apparatus. (15/10/18.)
135,244 B.T.-H. Co. (G.E. Co.) Electric welding machines. (18/10/18.)

Comprises means for welding metal sheets together successively edge to edge by advancing an electrode across the stock, a voltage regulator controlling the impressed voltage, and means for connecting the movable electrode and the regulator to raise the voltage impressed on the welder as the electrode advances along the joint for welding.

135,255 Sullivan, Osgood & Dean. Electrical switches. (18/3/19.)
135,260 Dale & Metropolitan Vickers Electrical Co. Electric switches or circuit interrupters. (15/11/18.)
135,265 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electro-magnetic lock-out switch. (15/11/18.)
135,282 Automatic Telephone Mfg. Co. (Automatic Electric Co.) Automatic telephone systems. (19/11/18.)
135,297 Horn. Mechanism for automatically and periodically operating furnace or other valves, electric switches or the like. (21/11/18.)
135,302 Dungey & Wingfield. Intercommunication telephone systems. (22/11/18.)
135,308 Whalley. Magnetos for internal-combustion engines and the driving provision therefor. (23/11/18.)
135,311 Fuke & New Switchgear Construction Co. Time lag devices for electric automatic switches and other electrical apparatus. (22/11/18.)
135,313 McColl. Combined differential and reverse power relay for the protection of generators and transformers. (27/11/18.)
135,346 Wade. (Fabbrica Isolatori Livorno.) Insulators for high-tension electric cables. (19/12/18.)
135,351 Butlers Limited & Reeves. Incandescent electric lamps suitable for automobiles and the like. (24/12/18.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

October 13, 1919.

24,950 Blaiberg. Starting electric generator plants driven by internal combustion engines, &c.
24,961 Speck. Electrically-operated hoisting devices.
24,975 Stockel. Accumulators, &c.
24,985 Rose. Visual and audible electric indicators.
24,995 Crew. Combination short-circuiting switch for motor-cars, &c.
25,018 Norsk Hydro-Elektrisk Kvaelstofaktieselskab. Effecting crystallisation from solution. (23/10/18, Norway.)
25,022 Sizaire. Attaching magnetos, dynamos, &c., to motors, &c.
25,039 Brydon & Johnson. Wireless telegraphy, &c.
25,052 Trembour. Electric furnaces. (24/3/16, U.S.)
25,053 Price. Commutating or switching.
25,065 Master. Electric tramcar pole-end.
25,068 Garde. Switches.

October 14, 1919

25,085 Thomas. Electric heating apparatus.
25,088 British Insulated & Helsby Cables, Ltd., & Astley. Continuity electricity conductors.
25,108 Norton. Switches, isolating links, &c.
25,120 Cheetham. High and low tension distributor of electricity for ignition in motor engines.
25,136 Joyce. Electric signal system.
25,160 Western Electric Co. & Polinkowsky. Machine switching telephone systems
25,163 Klein. Electro-medical apparatus.
25,172 Roe. Electric contact-maker for railways.
25,176 B. T.-H. Co. (G. E. Co.) Pneumatically-operated controllers for motors.
25,177 Metropolitan-Vickers Electrical Co., Erwan & Miller. Electrically-driven planer, &c.
25,182 Alloy Welding Processes, Ltd., & Jones. Electrode, welding rods, &c.
25,199 Johnson. Wiring conduit cap.
25,207 Rozewsky. Indirect lighting or illuminating systems. (14/10/18, Holland.)

October 15, 1919.

25,227 Potter. Thermo-electric system, &c.
25,230 Angold. Magneto hand-lamps.
25,243 Harrison. Adjustable tension spring for telephones.
25,271 Vlug. Apparatus for transmitting and receiving electric oscillations. (19/8/19, Germany.)
25,285 Cosophos-Werke Akt. Ges. & B ltshauser. Electric pocket lamps.
25,290 Delta Co. Electric ignition plug (29/4/19, Switzerland.)
25,302 Cesaro. Push-button switches. (8/2/19, Italy.)
25,307 Punga & Roos. Bar windings for electric machines. (4/5/18, Germany.)
25,333 B. T.-H. Co. (G. E. Co.) Motor control.

October 16, 1919.

25,416 Sykes Interlocking Signal Co. & Wills. Electrically-insulated rail joints
25,417 Sykes Interlocking Signal Co. & Wills. Insulating material.
25,356 Woods. Electrical earthing devices.
25,369 Automatic Telephone Mfg. Co., Smith & Harrison. Telegraph printing systems.
25386 Hall-Edwards. Conduits for wires, &c.
25,403 Alexanderson. Radio-signalling systems. (16/10/18, U.S.)
25,419 Greenley. Electrodes for batteries.
25,420 Vickers, Ltd., & Courteade. Dynamo-electric machines. (18/7/16, France.)
25,426 Galvin. Electrical petrol vaporiser for carburettors.

October 17, 1919.

25,434 Butlers, Ltd., & Reeves. Incandescent lamps for automobiles, &c.
25,435 Coxon & Williams. Renewal of filaments in metal filament lamps.
25,440 Ball & Parsons. Electric clocks.

Companies' Reports, &c.

The directors of GREENWOOD & BATLEY, LTD., have declared an interim dividend of 5 per cent. on the ordinary shares.

A quarterly dividend of 1¼ per cent. has been declared on the preferred stock of the ELECTRICAL UTILITIES COMPANY, LTD.

At an extraordinary general meeting of the ORIENTAL TELEPHONE & ELECTRIC COMPANY, LTD., on Tuesday, it was resolved that the sum of 2s. 6d. per ordinary share, being surplus money in the hands of the company, be appropriated as capital amongst the ordinary shareholders.

The directors of the LIVERPOOL OVERHEAD RAILWAY COMPANY recommend a final dividend (for the half-year ended Dec. 31 last) at the rate of 5 per cent. per annum (less tax), on the preference, and 4 per cent. per annum (less tax) on the ordinary shares, making for the year 5 per cent. on the preference and 3½ per cent. on the ordinary shares.

The directors of GUEST, KEEN & NETTLEFOLDS, LTD., have offered to purchase the ordinary shares in John Lysaght, Ltd. The latter company will remain a separate entity, but it is proposed to have an interchange of directors. The Earl of Bessborough, K.P., and Mr. Edward Steer will join the board of John Lysaght, while Messrs. H. Seymour Berry, D. R. Llewellyn, W. R. Lysaght, William E. Berry and H. G. Hill will become directors of Guest, Keen & Nettlefolds.

The directors of the BLACKPOOL and FLEETWOOD TRAMWAY COMPANY (which is in voluntary liquidation owing to the purchase of the undertaking by Blackpool Corporation) have asked the shareholders to send in their share certificates, and on receipt, £15 per share will be paid, £10 of which is the return of their original capital and £5 on account of surplus assets. The remaining assets will be distributed as soon as possible.

The EDISON SWAN ELECTRIC COMPANY, LTD., announces that Dr. G. L. F. Philips and Mr. A. F. Philips, of Philips Glowlamp works, Ltd., Eindhoven, Holland, have joined the Board of Directors of the Company. "The Financier" states that the Philips Company has acquired an interest in Edison Swan Company, amounting approximately to an eighth of the issued share capital of the company. Under an arrangement with the Dutch company, the Edison Swan Company will acquire the sole rights of sale and manufacture in Great Britain of the Philips lamp.

The revenue of the CHATHAM & DISTRICT LIGHT RAILWAYS COMPANY for the year ended Dec. 31 last was £78,839 18s. 3d. and expenses were £52,614 18s. 6d. After paying rent of Rochester Corporation lines (£3,743 12s.) and interest (£2,172), transferring £6,000 to reserve for depreciation and writing off £50 loose tools and adding amount from 1918 (£3,801 18s. 7d.), the balance is £18,061. The interim preference dividend at rate of 5 per cent. and the interim ordinary dividend of 4 per cent. for the half-year ending June 30 absorbed £7,180, and the directors now recommend payment of a 5 per cent. preference dividend and a 4 per cent. ordinary dividend for the half-year ended Dec. 31, 1919. After paying £307 18s. 6d. to directors, 10 per cent. of net profits after payment of 5 per cent. dividend on the ordinary share capital for the year, a sum of £3,393 is to be carried forward. There is an increase of £11,497 in the revenue and £14,069 in the expenses compared with the year 1918. There has also been an expenditure of £3,394 during the year on deferred repairs.

Prices of Metals, Chemicals, &c.

TUESDAY, Jan. 20.

		Price.	Inc.	Dec
Copper—				
Best selected.........	per ton	£123 0 0	—	£2 0 0
Electro Wirebars...	,,	£123 0 0	—	£3 0 0
H.C. wire basis......	per lb.	1s. $4\frac{9}{16}$d.	—	$\frac{5}{16}$d.
Sheet..................	,,	1s. $5\frac{15}{16}$d.	$\frac{1}{16}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. $8\frac{9}{16}$d.	—	$\frac{5}{16}$d.
Brass 60/40—				
Rod, basis	,,	1s. 0½d.	—	¼d.
Sheet, basis	,,	1s. 4⅛d.	½d.	—
Wire, basis	,,	1s. 4d.	½d.	—
Iron—				
Cleveland Warrants	per ton	£9 2 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£39 0 0	£3 10 0	—
Lead Pig—				
English	,,	48 10 0	—	£0 10 0
Foreign or colonial	,,	47 12 6	£0 2 6	—
Tin—Ingot	,,	384 15 0	£6 10 0	—
Wire, basis	per lb.	0 4 9	1d.	—

Salammoniac.—Per cwt. 95s. and 90s.

Sulphur (Flowers).—Per ton £23.

,, (Roll Brimstone).—Per ton £22 10s.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £42.

Boric Acid (Crystals)—Per ton £74

Carbon Bisulphide.—Per ton £56

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate.—Per lb. 6d.

Shellac.—T.N. Orange, 890s.

Rubber.—Para fine, 2s. 7¼d.; plantation 1st. latex 2s. 8¼d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd, and the rubber figures by W. T. Henley's Telegraph Works, Company.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Jan. 20, 1883.]

BRIGHTON.—The Town Council have resolved to oppose the application of the Union Electric Light Company for a provisional order.

DIRECT UNITED STATES CABLE COMPANY.—The board of this company have resolved upon the payment of an interim dividend of 5s. per share, being at the rate of 5 per cent. per annum, for the quarter ended Dec. 31, 1882.

ELECTRIC LIGHT AT LONG EATON (NOTTS).—Some of the leading lace makers in this district have determined to adopt the electric light, and have placed the work in the hands of the Hammond Electric Light & Power Supply Company.

ATLANTIC CABLE TRAFFIC.—It is stated that arrangements have been completed for the establishment of an independent submarine telegraph office in New York. The Direct United States and the Compagnie Française cables will be worked from the office, and will be entirely independent of the existing land wires in America, while they will at the same time be open to receive messages from any of the land wire systems of the United States.

ELECTRIC LIGHTING AND THE LADIES.—At a fancy dress ball, held at Hull recently, a lady somewhat electrified the remainder of the company by appearing with incandescent lamps ararnged about her person. To quote a local contemporary: "Small incandescent lamps were artistically introduced into the head-dress and other portions of the costume, and the electricity was supplied by a gentleman who was in attendance with a box representing a hand organ, from which were wires attached to the lamps." According to this extract, it seems a matter of conjecture as to whether the source of the electricity was the gentleman in attendance or the box representing the hand organ. The fact of the matter is that the box was a bichromate battery, which, together with the lamps and fittings, had been supplied by Mr. T. Muse, an electrician, of Hull. Now that "A.I.C.E." and "The Times" have discovered the somewhat careless manner in which they "rushed" in to support the claims of the lowly "super" (should it not be superess ?), whose life they discovered to be in danger at the hands of energetic and unscrupulous theatrical managers, no doubt many of the fair sex will follow the example set them at the Savoy Theatre, and again at Hull, and place electricity in the same category as rouge, pearl powder, eyebrow brushes *et hoc genus omne*. We only hope, for the sake of the ladies, that this "novelty" will not be found to have been in vogue amongst the Chinese a few thousand years ago.

ELECTRIC LIGHTING AT BERECHURCH HALL.—Mr. D. E. Coope, M.P., writes to "The Times" of Tuesday last, giving details of the cost of lighting his residence at Berechurch Hall by incandescent lamps. From this letter we make the following extracts: "I engaged the services of Mr. Heaphy, C.E., of the Phœnix Fire Office, to advise me upon the matter and superintend the installation on my behalf. We examined together every different system of lighting, the result being that I determined to adopt the Swan incandescent light and the Bürgin machine, and accepted the order of Messrs. Crompton & Company to supply the same after I had instructed Mr. Heaphy to draw up a regular specification and contract, going into every detail, and giving me the power of rejecting any work or materials he was not perfectly satisfied with. We arranged to have 200 lights of 18 c.p. each, and four dynamo machines; the engine to be of 12 H.P., with very sensitive governor, and with tubular boiler, all leads and wires to be heavily insulated in the best possible manner, and the insulation to be rendered non-inflammable inside the rooms. They were to be embedded in the walls, and kept at least 4 in. apart from each other, and 4 in. from every kind of metallic substance. Every floor, every room, and in many cases each light, to have switches to turn the current on and off, as well as a lead "cut out" to guard against over-heating of the wires. The whole has been carried out as specified, and the result has been a success that has exceeded my expectations. I will now give details as to cost: Estimate for gas plant, buildings and erection, £740; gas main to house, £75; laying pipes in house, £200; cutting and making good again, £50; chandeliers and brackets, &c., £268 18s.; total, £1,333 18s. Cost of electric light: Four dynamo machines, £405; 220 Swan lamps, £55; 200 sockets for same, £10; cable, wires, switches, and cut outs, £66 4s.; cutting and making good walls and floors and incidental work, £60; engine and boiler, extra flywheel and belting, £300 6s.; counter shafting, £25; foundations to engine and flooring, £40; erection, laying wires, &c., and carriage, £90; buildings, £150; chandeliers and brackets, &c., £268 18s.; total, £1,470 8s. I will now estimate the annual working expenses, and in making a comparison I will assume that it would cost the same to manufacture 1,000 cubic ft. of gas at Berechurch as it does here. Electric light: 200 18 c.p. lamps, each working 1,150 hours per annum. Coal at 20s. per ton, £38 10s. 1d.; engine driver at 30s. per week, £78; renewal of lamps, 153 at 5s. each, £38 5s.; depreciation, 10 per cent. on cost of machinery, £74; depreciation 5 per cent. on conductors, £4; total, £232 15s. 1d. Now, for less than half this amount of light, it costs me £200 a year here (Rochetts, Brentwood), and therefore I am, if anything, understating the expense when I say that, had I used gas at Berechurch giving an equivalent illuminating power, it would have cost me at least £400 per annum to produce. This would show an annual saving of £167 4s. 11d. to me by using electricity. Having had 20 years' experience of lighting this house by gas—which I consider a great improvement upon any previously known method—I am only too sensible of its drawbacks, and, although I am not doing away with it here yet, I am well satisfied that I have adopted electricity at Berechurch." We may remind our readers that we described and illustrated this installation in our issue of Dec. 2.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,176. [Vol. LXXXIV. No. 5.] FRIDAY, JANUARY 30, 1920. PRICE SIXPENCE. By Post. 7d Abroad. 9d

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Notes.

The Development of Engineering Laboratories.

"It seems almost to be recognised already that an engineering laboratory is an essential part of every institution training engineering students." This sentence is taken from a Paper read by Prof., now Sir, ALEXANDER KENNEDY before the Institution of Civil Engineers on December 21, 1886. In these days the statement is a truism, but at that time Prof. KENNEDY was among the few pioneers who saw that a student undergoing a theoretical course in engineering at a college or university must have his theory polished by making measurements with his own hands on simple apparatus, and thus finding out for himself just what can and cannot be done with various materials. In the Paper which we have just mentioned, Sir ALEXANDER KENNEDY lays down the essential features of an engineering laboratory, and illustrates his text by actual examples of what he himself had done at University College, London. He started the work which others have carried on, so that from small beginnings in 1878 the engineering laboratories at University College have increased and multiplied, and large numbers of engineering students have thereby benefited. It is, however, typical of this country's attitude towards engineering progress that these extensions have not been obtained without considerable anxieties of a financial kind, and now that once again a further development is required if the work is to be efficiently carried on, the college authorities are obliged to make an appeal for £100,000 for the reconstruction and re-equipment of the engineering buildings.

The Obstacle of Finance.

IN making this appeal the Committee, of which H.R.H. PRINCE ARTHUR OF CONNAUGHT is President, and Sir ALEXANDER KENNEDY Chairman, point out that the reconstruction and re-equipment of schools of engineering are inevitable at intervals if the schools are to retain their vitality. Some reconstruction of this kind is now due at University College as the last extension took place in 1893. Since that time not only has engineering in all its branches advanced considerably, and thus thrown greater responsibilities on those whose business it is to teach the principles of the subject, but, as far as electrical engineering especially is concerned, our knowledge has almost outstripped ordinary conception. In wireless telegraphy alone, with which the names of University College and Prof. FLEMING will be ever associated, a new science has grown up. At present funds are required for a general extension of the School of Engineering. Two additional floors will be provided on the present site, and a part of the south wing reconstructed to give more lecture room and other accommodation. This will allow the construction of a hydraulic laboratory, which is to be associated with the name of the late Mr. CHARLES HAWKESLEY. In the establishment of an engineering laboratory the equipment is as vital as the buildings, and it is therefore proposed of the £100,000 asked for to invest about £25,000 or £30,000, from the income on which it will be possible to renew the equipment from time to time. We are glad to see that from the preliminary list of donations that generosity of the right kind is being displayed by persons of widely different classes of the community; but, at the same time, more and more money is still required, and we hope that all electrical engineers, whether personally or as corporate bodies, such as firms and institutions, will see the desirability of subscribing generously to this very laudable object.

The Moulders' Strike.

THE fourth ballot taken by the members of the three moulders' unions since August last has resulted in a majority in favour of returning to work. The terms of the offer on which the ballot was taken are substantially those which were rejected only three weeks ago. In that case there was a majority of just over 7,000 against the acceptance of an increase of five shillings, and in this case there was a majority of 6,400 in favour of accepting the same increase. The numbers voting on the last occasion were greater than at the ballot at the beginning of January, and also greater than those on any other occasion, except at the first ballot in October, when a provisional settlement, which had been made by the men's representatives on the basis of a stabilisation of wages until September, 1920, was rejected by a majority of over 26,000 votes. In all cases the number of men voting were small in proportion to those employed, so that this would seem to be another case where a large body of men are willing to follow their leaders, both silently and blindly. Under the terms of the latest agreement, work was to be resumed on Monday last without victimisation on either side, and, as far as we can ascertain, this part of the agreement is being loyally kept, except in one or two instances. We have already given at some length our views on the various conflicting elements which led up to this strike and caused its long continuance. Fortunately, such discussion is no longer necessary, and we need say no more but to express our gratification that this dispute has at last been settled, and to reiterate our view that such a disastrous quarrel should never have been allowed to take place for so slight a reason.

The Bright Side of the Strike.

It is said by optimists that every cloud has a silver lining, though this fact is not encouraging to those enveloped in a deep fog. Engineering manufacturers may perhaps, therefore, be pardoned for failing to see how the moulders' strike has benefited them; but still it may be pointed out that there are one or two ways in which the checking of output has not been without its advantages. It has, for instance, enabled attention to be given to other matters of great importance which too often are put on one side in times of stress. It has enabled the drawing office staff to review their designs, the costing department to edit their card indexes and forms and to think out new systems for improving the organisation, the maintenance staff to overhaul their machinery and the tool room to do all sorts of jobs which will help to improve their stock. Many of the electricity supply undertakings have also benefited indirectly by the strike. As is well known, they are having extreme difficulty in coping with the load on their mains, and while on the one hand the moulders' strike has retarded the delivery of plant which would relieve the situation, at the same time it has temporarily reduced the number of those requiring current, and has enabled the much harassed station engineer to do something to get his house in order. This is looking on the bright side. But, nevertheless, these times of lull, however useful they may be, cannot be prolonged without disaster. With the return of the moulders to work we shall, therefore, hope to see production once again in the ascendant. That is our great, our ever-pressing need, and it speaks badly for our lack of propaganda of the right sort that the men themselves have not been able to see this before their funds were exhausted and their personal finances in a sore plight.

The Progress of Joint Industrial Councils.

All who are interested in bringing about a better understanding between employers and employees will read with satisfaction the announcement of the Ministry of Labour regarding the progress recently made in the formation of Joint Industrial Councils in various trades. During the past three months three National Councils on which the Government is represented as an employer have been established. In addition, six other industrial councils have been set up, making the present total 51. In this work of conciliation the electrical engineering trade has not been behindhand, and a number of councils dealing with various phases of electrical activity, such as contracting, electricity supply and tramways, have been established in various districts. We hope that the greatest good will come from this extension of the Whitley scheme, and that every encouragement will be given by all concerned to those who are working for a better understanding between two parties whose interests are really the same. Unfortunately the formation of these councils does not always mean peace. There has recently been a dispute between the members of the Electrical Trades Union in the Liverpool district and their employers which shows this. A short time ago a code of rules was agreed upon by the appropriate district Joint Industrial Council, and these rules were sent to the National Joint Industrial Council for approval. They were, however, returned with recommendations. When the district council met for a reconsideration, the members of the Electrical Trades Union refused to have anything to do with the matter, and made the usual threats if the rules agreed upon by the District Council were not put into force at once. Naturally, the local employers were unable to comply with this demand, and as a result there has been a lock-out in the Liverpool district. At first sight it seems as if the Whitley scheme has been a failure in this case; but some people will squabble about anything, and it is obvious, if these councils are to be a success, those forming them must be possessed of something of the spirit of sweet reasonableness which seems to be lacking in this instance. If a committee formed of members of opposing parties meet together, and each side is determined not to abate one jot of their demands, trouble can only be the result. There must be some give and take. On these councils there is no room for reactionaries or Bolsheviks, and it should be the aim of that very large majority of those engaged in electrical work, to whom neither of these labels can be applied, to come together and enforce conciliation. The Whitley Councils have the roots of the matter in them, and we must not allow them to be wrecked by those whose delight is agitation and strife.

Electricity in Housing and the Quality of Cables.

Nothing has done so much disservice in the past to the cause of electrical development as the unsuitability of a great deal of the apparatus employed. It is true some of this equipment was admittedly experimental, but this must be said more by way of explanation than excuse. The proper place to try out new apparatus is in the laboratory and on the test bed, and not on the consumer's premises. Or, if this be thought too sweeping a statement, it may be modified by saying that all electrical equipment supplied to the ordinary householder should be of a design and construction which has stood the test of time, and of a pattern which is at least likely to be suitable for domestic purposes. Experiments under actual working conditions should, in a word, only be made in the houses of selected persons who know within limits what the apparatus can and cannot do, and will not be surprised at occasional spectacular failures. These statements apply equally to everything electrical which may be employed in the ordinary household, from the ceiling rose to the most elaborate cooker; and especially they apply to the wires and cables. Unless the wiring is properly executed, and unless the wires themselves are properly manufactured, trouble must sooner or later result. It is important to call attention to the necessity of the employment of suitable wires and cables at the present time. We rightly expect to see a new development in the use of electric lighting as a result of the work that is being done under housing schemes in various parts of the country; but that development will be retarded if attention is not paid to this very essential part of the work. Fortunately, it is now easier than it was to fulfil these conditions. The flow of cheap wire and cable from Germany and other places abroad has ceased. British made material must be used, and there is no reason why shoddy should be employed, as there is plenty of good stuff. The Cable Makers' Association may be a trust, but it is a trust the members of which have reputations to lose, and feel, therefore, that it is better to produce good material rather than bad. Their label, with its left-handed figure helmeted with what looks like a reversed blacking brush, is an indication that a certain standard of quality is guaranteed, and contractors have, therefore, no excuse for buying anything of an inferior quality, and have only themselves to thank if they do. That being so, we hope that every effort is being made to prevent reproduction of these labels by unauthorised persons, and that the affixing of old labels to inferior material, if effected, will be made a practice for which its perpetrators will be punished. This is a necessary precaution, and we should have thought a lead seal pressed on to the end of every coil would have been better than a label for this purpose.

The Fallacy of Cheapness.

IN the discussion at the Institution of Electrical Engineers on Mr. J. SHEPHERD'S Paper on "The Failures of Turbo-Generators," Dr. S. P. SMITH raised an interesting point. He said that the buyer in this country did not go for the best but for the cheapest machine. As a result the buyer got the cheapest machine and with it the troubles inherent in cheapness. This at first sight seems a very good argument against the policy of accepting the lowest tender. It would, however, be a still better argument if those whose business it is to buy machinery, or any other commodity for that matter, were certain that, while cheapness meant bad design and bad workmanship, a high price meant good design and good workmanship. This is by no means always the case. In this connection it is interesting to consider the proportion in which design and workmanship affect the performance of a particular machine. It is obvious that a badly designed machine will not perform so well as a well-designed one whatever the workmanship; and equally obvious that a machine in which good workmanship is a feature will operate better than a machine in which bad workmanship is predominant, the design being the same in each. But what about the operation of a machine which is well designed and badly executed, or a machine which is badly designed and well executed? No general rule can be laid down as to its operation. Even a knowledge of the proportion of good and bad present will not give the desired solution. Moreover, a manufacturer with a reputation to lose is very careful of the workmanship and material he puts into his products, and over both he has a considerable amount of control; but the same cannot be said of design, which advances to a large extent by the paths of trial and error, guided by the dim light of experience, it is true. It was to show some of the pitfalls along these paths that Mr. SHEPHERD was chiefly concerned.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

On page 108 we publish the conclusion of Dr. C. V. Drysdale's article on "A Universal Inductance and Capacity Testing Bridge." in which he deals with inductance and capacity tests which can be made with the instrunent.

On page 110 we publish an article by Mr. W. J. Hiscox, in which he discusses the effect of the proposed increase in the tube railway fares in the engineering industry of London. In the past the worker in the engineering industry has only been attracted to London by higher wages and the fact that though he has been obliged to live at some distance from his work he can travel to and fro at a low cost. This advantage, the author considers, will disappear if the fares are increased, with the result that the worker will once more be attracted to the provinces.

An interesting development in wireless telephony and telegraphy is dealt with on page 111, where we give an abstract of an article by Major-General G. O. Squier, of the United States Army. He describes the results of certain experiments made by using trees as antenna and shows that very satisfactory results can be obtained by their employment.

On page 113 we conclude our account of the report of the Nitrogen Products Committee. Various processes which have been commercially developed are discussed. An account of the research work undertaken by the Committee is described and the post-war aspects of the nitrogen problem are gone into.

On page 115 we give an abstract of a Paper on "Transformers for Electric Furnaces," recently read before the Institution of Electrical Engineers by Mr. J. L. Thompson, in which the author deals with various problems which must be overcome in designing transformers for this special class of work.

On page 117 we continue our account of the recent Physical and Optical Society Exhibition.

On page 122 we publish a letter from Senatore Marconi disclaiming certain statements attributed to him by the Daily Press.

In our Leading Article we discuss certain aspects of the electric power production problem. Investigations made by the Nitrogen Products Committee show that the direct firing is the most economical method of employing coal for obtaining electric power (page 123).

Arrangements for the Week.

FRIDAY, Jan. 30th (to-day).

Institution of Civil Engineers.—Students' Meeting

6 p.m. At Great Geoge-street, London, S.W. Lecture on "The Economic Requirements for Inland Navigation Transport in the British Isles," by Mr. R. B. Dunwoody. (Lecture II.)

Institution of Electrical Engineers.—Students' Meeting.

7 p.m. At the City and Guilds Technical College, Leonard-street, Finsbury, London, E.C. Discussion on "Quantity Production as a Panacea," to be opened by Major K. Edgcumbe.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Paper on "The Manufacture of Hydrogen Gas by the Silicol Process for Airships and Commercial Purposes," by Mr. G. E. Lygo.

Royal Institution.

9 p.m. At 21, Albemarle-street, London, W. Discourse on "The Gyrostatic Compass," by Mr. S. G. Brown, F.R.S.

SATURDAY, Jan. 31st.

Royal Institution.

3 p.m. At 21, Albemarle-street, London, W. Lecture on The Astronomical Evidence bearing on Einstein's Theory of Gravitation: Lecture I. "Movement of the Perihelion of Mercury," by Sir Frank W. Dyson, F.R.S.

Stoke-on-Trent Association of Engineers.

7 p.m. At the Council Chamber, Town Hall, Hanley, Stoke-on-Trent. Paper on "Alternating Current Motors," by Mr. R. P. Hulse, B.Sc.

MONDAY, Feb. 2nd.

Institution of Electrical Engineers.—Informal Meeting.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn Buildings, London, W.C. Discussion on "Engineering Experiences during the War," by Major T. R h. O.B.E.

Institution of Electrical Engineers—Western Centre.

7 p.m. At the South Wales Institute of Engineers, Park-place, Cardiff. Paper on "Large Power Transformers," by Mr. A. G. Ellis and Mr. J. L. Thompson.

Society of Chemical Industry.

8 p.m. At Burlington House, Piccadilly, London, W. Paper on "The Theory and Practice of Lubrication: The Germ Process," by Mr. H. M. Wells and Mr. J. E. Southcombe, M.Sc.

TUESDAY, Feb. 3rd.

Institution of Electrical Engineers.—N.-Western Students' Centre.

7.30 p.m. At Houldsworth Hall, Deansgate, Manchester. Paper on "The Manufacture and Electrical Properties of Porcelain Insulators," by Mr. R. T. Fleming.

WEDNESDAY, Feb. 4th.

Institution of Electrical Engineers.—Scottish Centre.

7 p.m. In the St. Andrew's Hall, Granville-street, Glasgow. Conversazione.

Industrial League and Council.

7.30 p.m. In the Conference Hall, Central Hall, Westminster, London, S.W. Lecture on "Conditions the Workers may Control," by Major E. A. Pells.

Paisley Association of Electrical Engineers.

7.30 p.m. At the Y.M.C.A. Buildings, 25, High-street, Paisley. Paper on "Oil," by Mr. W. Murray.

Institution of Automobile Engineers.

8 p.m. At the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W. Paper on "The Process of Ignition," by Mr. A. P. Young and Mr. H. Warren.

THURSDAY, Feb. 5th.

Royal Institution.

3 p.m. At Albemarle-street, London, W.1. Lecture on "Recent Progress in Applied Optics," by Prof. A. E. Conrady. (Lecture I)

FRIDAY, Feb. 6th.

Institution of Electrical Engineers.—Students' Meeting.

7 p.m. At the City and Guilds (Eng.) College, S. Kensington, London, S.W. Paper on "Electric Lifts and Cranes," by Mr. F. R. Housden, A.C.G.I.

SATURDAY Feb. 7th.

Royal Institution.

3 p.m. At Albemarle-street, London, W.1. Lecture on The Astronomical Evidence bearing on Einstein's Theory of Gravitation: Lecture II. "Displacement of Solar Spectral Lines," by Sir Frank W. Dyson, F.R.S.

A Universal Inductance and Capacity Testing Bridge.

By C. V. DRYSDALE, D.Sc., M.I.E.E.

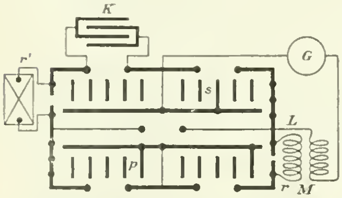
(*Concluded from page 82.*)

B.—INDUCTANCE TESTS.

Maxwell's Comparison of Inductance (Fig. 8).—The inductance L' to be tested and a variable standard inductance, L, are connected in adjacent "series" gaps, as shown. Suitable ratios, q and s, are chosen, and balance obtained by varying the inductance L and resistance R'. Then

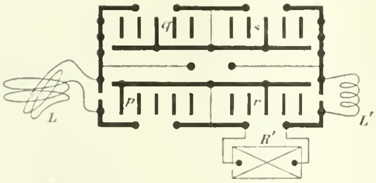
$$L'=\frac{s}{q}L,$$

and is direct reading.



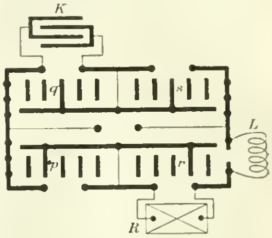
$$K=\frac{M}{(p+r)s}\cdot\cos\phi=\frac{L-M(1+r'/s)}{p+r}\,\omega.$$

FIG. 6.—CAREY-FOSTER CONDENSER CAPACITY AND POWER-FACTOR TEST.



$$L'=\frac{s}{q}L.$$

FIG. 8.—MAXWELL'S COMPARISON OF SELF INDUCTANCES.

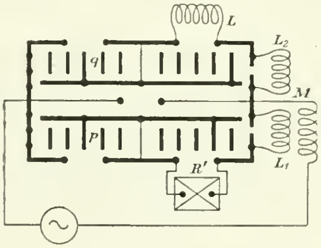


$$L=Kps.$$

FIG. 9.—MAXWELL'S COMPARISON OF INDUCTANCE WITH VARIABLE CONDENSER.

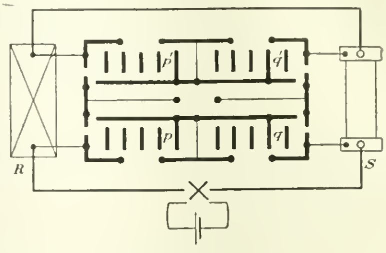
Maxwell's Comparison of Inductance with Capacity (Fig. 9).—This is a very convenient method with the variable condenser. The inductance L to be tested is connected in one "series" break, and the variable condenser in the diagonally opposite "shunt" break. The resistance box R is arranged to shunt one of the resistances, say R, and balance is obtained by varying K and R. Then $L=Kps$, and the resistance of the coil tested $=r^2/R+r$. The inductance test is direct reading, and the range from 10^{-9} henry (1 cm.) to 1·11 henries with the 1·11 mfd. condenser.

Anderson's Comparison of Inductance with Capacity (Fig. 10).—When a fixed capacity only is available, Anderson's method is the most convenient, although it cannot be made direct reading. The arrangement is the same as in Maxwell's method just described, except that a resistance box is connected in series with the condenser across one "shunt" gap, and one end of the galvanometer or telephone is connected to the junction between them. Balance is obtained by varying the resistances R and R', and then $L=Kp\left\{R'\left(1+\frac{s}{q}\right)+s\right\}$. The variable condenser method is, however, greatly to be preferred, as considerable experiment is sometimes necessary to get balance in the Anderson test.



$$pL_2-qL_1=(p+q)M.$$

FIG. 11.—CAMPBELL'S COMPARISON OF SELF AND MUTUAL INDUCTANCE.



$$\text{if }\frac{p}{q}=\frac{p'}{q'},\quad R=\frac{p}{q}S.$$

FIG. 12.—KELVIN DOUBLE BRIDGE FOR LOW RESISTANCE, OR ELECTROLYTIC RESISTANCE TUBING.

Comparison of Self and Mutual Inductance (Fig. 11).—This method, which has been recommended by Mr. A. Campbell, consists in connecting the secondary of a mutual inductance in one "series" gap as shown, and an approximately balancing fixed inductance, L_2, in the adjacent series gap. One of the alternator connections is made through the primary of the mutual inductance M. The coil L to be tested may conveniently be connected in the adjacent "shunt" gap, and be short-circuited at first by putting a plug in the zero position in that arm. Then, if the balance is obtained by varying the mutual inductance M and resistance R',

$$pL_2-qL_1=(p+q)M_0.$$

Upon withdrawing the short-circuiting plug and re-balancing,

$$p(L_2+L)-qL_1=(p+q)M,$$

from which

$$pL=(p+q)(M-M_0),$$

and

$$L=\frac{p+q}{p}(M-M_0).$$

By inverting this method

$$M-M_0=\frac{p}{p+q}L,$$

from which a mutual inductance can be determined from a variable self-inductance standard.

Mutual inductances may also be determined by a variable condenser by inverting the Carey-Foster test (Fig. 6), when $M=(p+r)sK$, which is direct reading if $p+r$ is made a decade value.

C.—LOW RESISTANCE MEASUREMENT.

Incidentally, it may be mentioned that the apparatus makes a fairly efficient Kelvin double bridge if connected as in Fig. 12 and used with an ordinary battery and galvanometer. With ratios

$$\frac{p}{q}=\frac{p'}{q'}=\frac{1{,}000}{1}.$$

and with the five-dial resistance box R reading down to 0·1 ω, resistance can be determined with fair accuracy down to 0·0001 ω, or lower by interpolation.

D.—ELECTROLYTIC RESISTANCE MEASUREMENT.

The bridge serves excellently for measurements of the resistance of liquids, which has assumed great importance recently, notably as regards bacteriological investigations, in which the resistance of the liquid is found to be a very accurate criterion of its acidity, which is affected by the growth of bacteria. If a tube of the liquid to be tested is substituted for the resistance S in Fig. 12, with inner electrodes as potential terminals, polarisation effects are greatly reduced and remarkably consistent measurements can be made by using alternating currents. A valve amplifier and telephone may be used as detector if desired for measurements with very low potential gradients, and any capacity effect may be determined by connecting the variable condenser across the arm.

Fig. 13 shows the type of tube and electrodes which have been found most suitable for such tests.

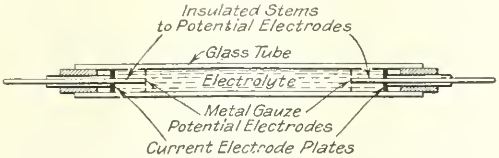


FIG. 13.—TUBE AND ELECTRODES FOR MEASUREMENT OF THE RESISTANCE OF ELECTROLYSIS.

The Paper by Mr. Rivers-Moore on "The Conductivity of Sea Water," which appeared in the ELECTRICIAN of February 7th last, shows the applicability of the bridge for electrolytic resistance measurements. Remarkable consistency was found in the values of the specific resistance obtained over a very considerable range of current, frequency and length of liquid column.

The apparatus has been used for some time past in the test room of Messrs. H. Tinsley & Company, both for capacity and inductance tests, and for the preliminary adjustment of low-resistance standards.

Fig. 14 shows a convenient form of variable self and mutual inductance standard devised by the author for use with this bridge. It is of the well-known parallel disc form, with oval coils; but each disc has separate terminals, so as to be used separately as a mutual inductance standard, or in series as a self-inductance standard. As ordinarily made, each coil has an inductance of about 25 millihenries and resistance of 30 ω, and when the two coils in each disc are joined in parallel the mutual inductance varies from 0 to ±7 millihenries, with a resistance of 15 ω in each circuit, and the self inductance of the two discs in series from 6 to 40 millihenries. By connecting the two coils in each disc in series, however, the inductance and resistance are each increased exactly four-fold, so that the total range of mutual inductance is from 0 to ±30 millihenries, and of self inductance from 6 to 150 millihenries, which, with the range of resistance in the bridge, enables inductances to be tested from 6 microhenries to 150 henries. The apparatus is provided with two scales reading the self or mutual inductance directly, and with a small change-over switch for simultaneously changing the connections of the coils in both discs into series or parallel.

Although the foregoing diagrams show the more commonly used tests, practically every bridge method of measuring inductances and capacities can be adapted to it very easily and quickly, and the compactness and symmetry of the bridge and connections renders interference errors much less likely. The bridge and accessories are made by Messrs. H. Tinsley & Company, of Werndee Hall, South Norwood, who have issued a descriptive pamphlet giving numerical examples of the various tests.

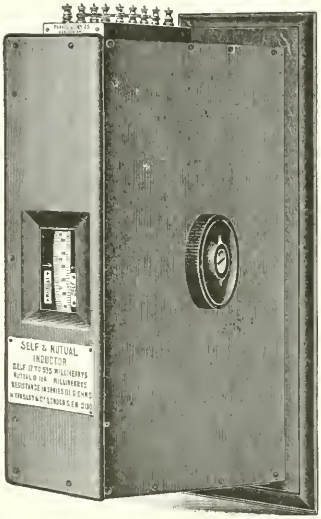


FIG. 14.—VARIABLE SELF AND MUTUAL INDUCTANCE STANDARD.

Electric versus Steam Locomotives.

An interesting "practical" test of the relative hauling powers of a steam and electric locomotive is described in the "Scientific American." The electric locomotive was 78 ft. in length, 17 ft. high, and weighed 265 tons. It was driven by direct-connected motors mounted on its 14 axles, and was supplied with direct current at 3,000 volts. Its horse-power was 3,240. Tests showed that the gearless electric locomotive works at 10 per cent. higher efficiency at 50 m.p.h. than the geared type, and this locomotive has been designed for handling a train weighing 960 tons on a gradient of 2 per cent. at 25 m.p.h.

This huge locomotive was coupled to two modern and powerful express steam locomotives. To avoid the possibility of accidents, the test was carried out by having the contestants push instead of pull against one another. The result was an undeniable victory for the "electric." To quote from our contemporary's account "the steam engines were forced backward, first only by inches, but gradually as the full power of the electric locomotive was brought into play, the procession became a rout, and when the test ended a few minutes later, the steam locomotives were moving steadily backwards."

Although we welcome this account of the powers of the electric locomotive over the more ordinary steam type, it would be interesting to know rather more about the conditions involved, and especially the horse power of the steam locomotives, and whether both electric and steam engines were started simultaneously.

Will the Tube Fares be Increased?

The Effect on the Engineering Industry of London.

By W. J. HISCOX.

The proposed drastic revision of tube and tram fares has caused something approaching consternation in the industrial circles of the metropolis, and should these proposals materialise the effect will react upon industry in no uncertain manner. At a time, too, when the housing conditions are such as have never before been experienced, when labour is in such a volcanic state that the utmost tact and consideration is necessary, and when harmonious working was never before so essential to our national well being, it seems incredible that such a proposition could be seriously contemplated. No matter from what standpoint it is viewed, it appears to be the supreme height of folly, being fraught with such serious consequences as to merit the grave attention of all classes of the community.

We who have the good will of the engineering industry at heart, who have ever been optimistic of its speedy recovery from the battering it has received, and who have striven conscientiously for the intelligent and active co-operation of all classes, must feel somewhat disheartened at the thought that, just as our efforts appeared to be showing results, they should be thrown back by such a reactionary proposal. And we in London, knowing full well the peculiar disadvantages under which we labour, feel now that those disadvantages, which were gradually becoming less apparent, have reappeared in greater strength. The engineering industry, in which the readers of this journal are interested, will undoubtedly be seriously affected should the proposals mentioned become an established fact, and it behoves each one of us therefore to remember that all—employers and employees—must feel the consequences. Not only have we to consider its probable effect upon labour unrest, but also its effect upon the obtaining of adequate and efficient labour.

Before the war, the engineering industry of the metropolis was at a discount, and could not compare, or compete with, the great industrial areas of the Midlands and the North. The reasons can briefly be enumerated: Higher rents, higher rates, lack of space, and last, but not least, an inadequate supply of efficient labour. Your skilled mechanic came not to the south; he nearly always turned to the north, and if by chance one turned his steps in this direction, it was only as a result of a bribe—by way of higher wages.

There was plenty of labour available—of a sort—but no sooner did a man become proficient than he was away—to the Midlands or the North. The provincial mechanic had no yearning to come to London, for he gained nothing by so doing. Thus it was that the London engineer had to pay more for inferior labour than his northern competitor did for the efficient worker, and it cannot be wondered at, therefore, that as a competitor he was at a grave disadvantage.

The war, however, gave the London engineer his chance, and he took the fullest advantage of it. Efficient labour was more equitably distributed, and with food control operating throughout the country, the worker was as well off in London as elsewhere—so he stayed. The one great drawback was the housing question, but by travelling a few miles per day he was able to set up a home in the suburbs, rejoicing in the fact that, although the travelling facilities were conducive to discomfort rather than otherwise, they entailed no great pull upon his purse strings. The conclusion of the war saw the London engineering industry in a stronger position than ever before, and it soon became apparent that many of the disadvantages under which it had laboured for so long had disappeared, and that it was in a position to compete with provincial rivals. The last year has abundantly proved the truth of this, and there was every hope that this year would see the results which are to be attained by constant application and earnest endeavour.

Now, however, like a cloud of the size of a man's hand, a new trouble appears on the horizon—a new obstacle, probably more formidable than those which have gone before, which must be encountered and overcome. That it will be ultimately surmounted is beyond all doubt, but the mischief it is likely to cause ere it is conquered will be tremendous. It will be added fuel to the fire of labour unrest, for already the firebrands are leaping up, and it looks as though some people, either by accident or design, will succeed in forcing that great mass of intelligent labour into the hands of those from whom, to the present, it has kept clear. To put the matter in a nutshell, the London engineer cannot compete with the provincial unless he has equal facilities in the matter of efficient labour, and if the proposed increases in connection with tube and tram fares become operative he will not get it. As before mentioned, the travelling facilities offered to the Londoner have never been conducive to comfort—in fact, the business for some time has been a perfect nightmare, the intensity of which can never be realised by those who have not experienced it—but they have, at all events, provided the means of reaching work from a suburban home, at a rate which made but a small addition to the house rent. A fact that must be borne in mind is that the worker considers his travelling fares as part of the house rent in calculating his accounts, for if he pays 15s. per week for the house and 3s. per week for fares, then he puts down rent at 18s. per week.

Consider then the effect a drastic increase of his travelling expenses will have upon his income, and ask yourself if he is likely to be contented. His first impulse, perhaps, will be to endeavour to bring his home nearer to his work, but with the housing problem in its present condition, his efforts in this direction are not likely to meet with success. The next move is to demand higher wages, and failing in this he will seek the earliest opportunity of migrating to the provinces. It may be argued that the shortage of houses is not confined to London, and that the difficulty likely to be experienced in this connection will persuade him that, even with the higher travelling expenses, he is better off where he is. This may be so under certain conditions, but when a man is labouring under what he considers an injustice, he is usually determined to travel wider, even though he may fare worse, rather than to submit. He will secure a fresh job, bear the discomfort of lodgings, and stand the expense of maintaining two homes for a considerable period, rather than pay the toll demanded of him.

The employer will suffer, of course. He will be faced with the alternative of losing his best labour, or paying more for it. Whichever course he adopts he will be saddled with the disadvantages existent in pre-war days, and under such circumstances how *can* the London engineer compete with the provincial? Many people travel six, eight and ten miles each day to work, and at 2d. per mile the expense incurred will be considerable. Is it conceivable that anyone can be expected to pay £1 per week for the privilege of getting to work? The whole business is so manifestly absurd as to render it incredible that anyone with a grain of intelligence could entertain it for a moment. The average worker in the engineering factory is on duty for 4½ hours on Saturday morning. Will he pay 50 per cent. of what he will receive to provide himself with travelling facilities in order to earn it?

The London engineering industry wants every efficient worker it can get, and the term "worker" here includes every phase of the industry—managerial, administrative, productive. We cannot allow *anybody*, no matter how highly placed, to dictate to us in this respect. *We* have received no help from outside sources, neither did we expect it. When our troubles and difficulties became known, we were told to re-organise—and we did. Can we not pass on the suggestion to those who now propose to lighten their burdens by passing the greater portion of them over to other people? *That* is not re-organisation, but re-adjustment, and whilst any fool can re-adjust (so long as other fools are available for the purpose) only a genius can re-organise. One wonders if this is the reason for the suggested revision of fares.

So far from increasing the burdens of the travelling public, the time is ripe for a reduction. London is a fairly big place, and its inhabitants cannot all live within the sound of Bow Bells. Power conveyance, therefore, is an absolute necessity, and being a necessity it must be up to the standard. The Underground, 'bus and tramway companies undertook the business, and they must carry out their obligations. If they cannot do so, we must get someone who can. We want big men on a job of that description, not pigmies, and the fact that the transit facilities have been a scandal for years suggests that a change of control would be an advantage.

Come what may, we must retain the position we have won, and never again must the London engineer be at a disadvantage when competing with provincial rivals, as in the days before the war.

Tree Telephony and Telegraphy.*

By Major-General GEORGE O. SQUIER.
(Chief Signal Officer United States Army.)

Introduction.—In 1904 the author conducted some experiments with a view to utilising growing trees as antennæ for radio telegraphy and discovered the efficacy of using a direct metallic contact to certain trees (principally eucalyptus) to increase the audibility of radio signals. His attention was first called to this phenomenon during the course of summer manœuvres of the Army Camp at Atascadero, California, where, due to the prevalence of the dry season and the unusual character of the soil, it was found that the regular army buzzer telephone and telegraph sets were inoperative with any ordinary ground or earth, but became operative when connected to a metallic nail driven in the trunk or roots of a tree. Quoting from an account of subsequent experiments the author remarks that it "would seem that living vegetation may play an important part in electrical phenomena. Living vegetable organisms absorb and conduct electromagnetic oscillations over a wide range of the electromagnetic spectrum, beginning with sunlight, and extending to waves of identical character, but of immensely greater lengths, such as Hertzian radiation, telephonic waves, and oscillations of the ordinary low frequencies used in commercial electric transmission lines. Disruptive discharges between vegetable electrodes and electrostatic effects between vegetable surfaces are easily produced. The experiments referred to suggest that the earth's surface is already generously provided with efficient antennæ, which may be utilised for space telegraphy. A growing tree, covered with foliage, is influenced inductively by electrical disturbances outside of itself, and becomes generally responsive to induced electrical oscillations. It should offer, therefore, a promising means of studying meteorological effects of an electrical character, particularly those of lightning discharges, and the electricity of the air. One of the first practical rules for the preservation of life against lightning is to avoid the vicinity of a tree. Great forest areas may exercise an influence in maintaining a general equilibrium between the electrical charges of the upper atmosphere and the earth, and comparisons between observatories from the interior of great desert areas devoid of any vegetation, with those from other portions of the earth's surface well covered with forests, would be instructive. Thus, the general surface of the earth may be considered as supplied by nature with innumerable meteorological observation towers, which may be employed by means of apparatus involving principles already well known to science. Vegetation should be studied more systematically, from a distinctly physical standpoint than has been done in the past."

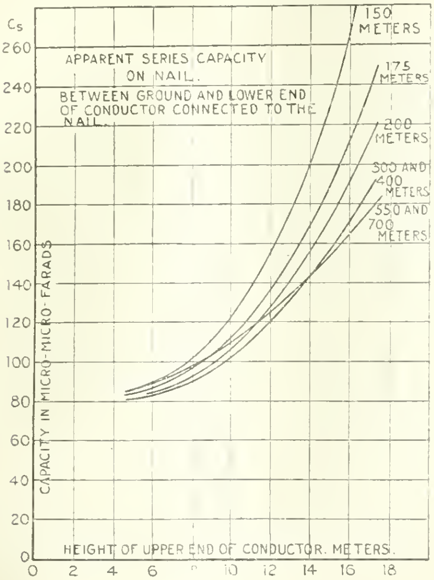


FIG. 1.

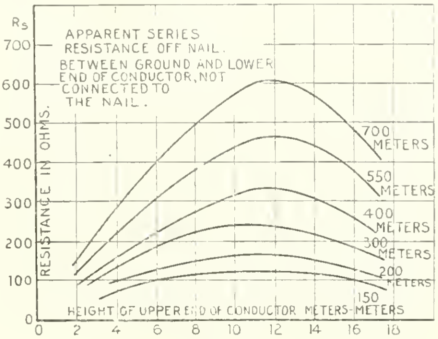


FIG. 2.

Tree Antenna.—In connection with the organisation and development of transatlantic radio reception carried out during the period of the war the Signal Corps established a chain of special receiving stations in different parts of the United States to copy and record enemy and allied radio messages from European stations for the information of our Army General Staff. Directions were given to the Signal Corps Laboratory at Camp Alfred Vail, Little Silver, New Jersey, and also to the experimental staff in Washington to test the efficiency of growing trees as receiving antennæ in connection with this service.

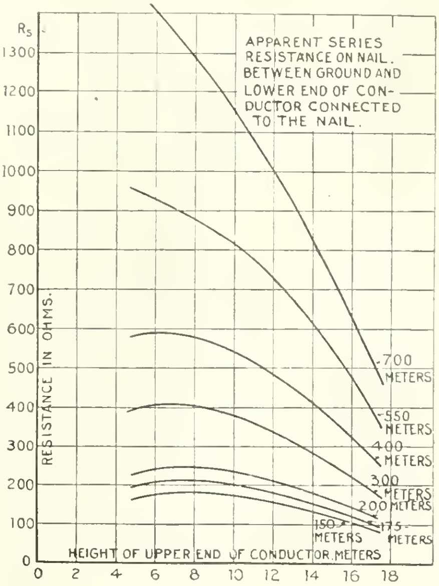


FIG. 3.

The problem, as a war measure, was attacked anew. It was immediately discovered that with the sensitive amplifiers now in use it was possible to receive signals from the principal European stations by simply laying a small wire netting on the ground beneath the tree and connecting an insulated wire to a nail driven in the tree well within the outline of the tree top. One of the best receiving arrangements is found to be an elevated tree earth-terminal in the upper part of the tree top, and an earth consisting practically of several short pieces of insulated wire sealed at the outer ends radiating out from a common centre, and buried a few inches beneath the surface of the ground in the neighbourhood of the tree. It was soon found that a tree-antenna could be used efficiently as a multiple receiving set over widely different wave lengths, receiving either from separate terminals at the same or different heights of the tree or in series from the same terminal. This same type of circuit was employed in an inverse manner for telephonic transmitting purposes, and it was found that two-way telephonic communication over short distances was easily established with remarkably low values of transmitting antenna current. The flexibility of this arrangement is very striking. The linking up of wire and wireless methods was found to be convenient and efficient. Radio telephonic messages from airplanes were readily received by the tree-antenna arrangement and transferred thence to the wire system of the City of Washington, and finally received at any point desired. Furthermore, telephonic transmission through the tree-antenna was received by another tree-antenna, and automatically returned to the sender on a wire system, thus making the complete circuit. Long-distance reception on any wave length from all the larger European stations, and from our ships at sea, was easily accomplished and traffic copied on a twenty-four hour schedule by the regular enlisted operators of the Signal Corps. A small portable house serving as a field laboratory was erected in the midst of the forest area on Grant-road, Washington, D.C., between the Bureau of Standards and Chevy Chase, Maryland, and here was assembled a collection of the most efficient vacuum tube amplifiers developed to date by the Signal Corps of the Army, the Navy, the British and the French, and of commercial firms in the United States.

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* Abstract of a communication to the Journal of the Franklin Institute.

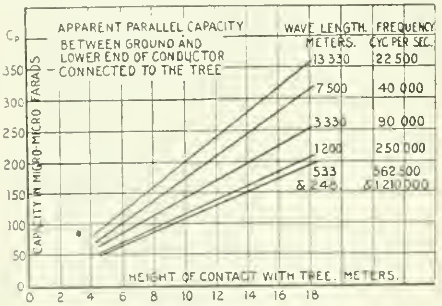

Fig. 4.

Electric Data on Tree Antennae.—Data on the electrical constants of tree-antennæ have been obtained by Capt. F. E. Pernot, Signal Corps, in charge of the Signal Corps radio research laboratory at the Bureau of Standards. Early experiments served to ascertain the relation between the audibility of received signals and the height of the tree contact above the ground, but gave no data concerning the magnitudes of the electrical properties which characterised such an antenna system. It is the intention here to examine more closely into such properties.

The two quantities which serve to characterise an antenna system are (1) the apparent impedance of the antenna as measured at the particular frequency in question from the two terminals which lead to the receiving set, and (2) the electromotive force at these terminals when they are open-circuited.

The results of a series of experiments on a pine tree are assembled in the original Paper. Tree contact was made through copper nails driven three inches into the tree. Ground contact was made through a bundle of copper wire buried three feet deep in moist soil. Three grounds were installed so that the individual resistances could be determined. An average value for this resistance with direct current was 150 ohms. At radio frequencies, on account of capacity effects, this resistance was much smaller. Using the substitution method, measurements of the apparent series capacity and resistance of the lead alone and of the lead attached to nails driven into the tree at various heights were made at different frequencies. In all cases the lead was of just sufficient length to reach to the point of contact, whether connected electrically to the nail or free. Some families of curves obtained from these tests are shown in Figs. 1, 2 and 3. Wave lengths from 150 to 700 metres are covered. The small change in the electrostatic capacity occasioned by making electrical contact with the tree, while other conditions remain unaltered, and the large increase in resistance, are to be remarked. The increase in resistance is particularly pronounced for small heights and long wave lengths. No correspondence is to be observed between the resistance curves as determined by these measurements and the curves representing the radiation resistance of a simple vertical wire. The explanation of such large resistance values in case of true antennæ is probably to be found in the effect of the immediate proximity of partially conducting media to the conducting lead. For long waves (low frequencies) the substituting method was not satisfactory, so another method, in which the antenna of unknown properties was shunted around a condenser, which constituted a portion of a resonant circuit, was used. This method of measurement yields the apparent values of the antenna constants, when they are considered as elements in parallel. Figs. 4 and 5 were thus obtained. The apparent capacity curves in Fig. 4 are instructive, indicating, as they do, a capacity proportional to the height of contact.

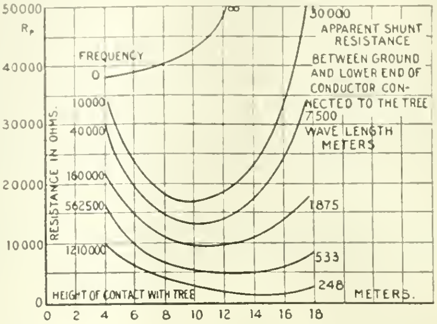

Fig. 5.

Besides showing capacity and resistance as functions of height of contact, they may also be plotted as functions of frequency, or, as happens to be more convenient in this case, the square root of frequency. Such a curve is shown in Fig. 6.

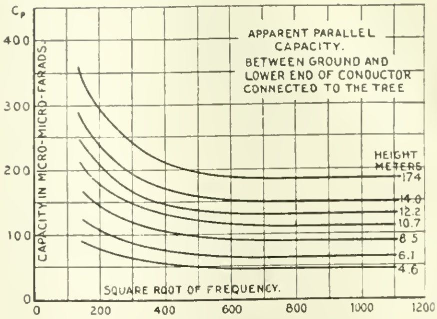

Fig. 6.

It can be shown that the receiver constants for which a maximum energy extraction from the antenna is obtained are: (1) The receiver inductance should be such as to resonate with the apparent antenna capacity at the frequency in question. (2) An effective receiver resistance equal to the apparent resistance of the antenna at the frequency in question.

An inspection of the foregoing curves shows that, in general, the effective antenna resistance is many times the apparent resistance of antennæ ordinarily used; the design of receivers should, therefore, be materially altered in order to utilise the energy impinging upon the tree to te best advantage. Except for very weak signals, however, it is not necessary to utilise this energy to the fullest extent, so that receivers of present design may be used, and when so used, are responsive to any wave length of radiation.

(*To be concluded.*)

The Report of the Nitrogen Products Committee.

(Concluded from p. 83.)

COST OF THE CYANAMIDE PROCESS.

In the case of the cyanamide process the power requirements in the latest apparatus used amount to about 16·5 kw.-hours per kilogramme of nitrogen fixed or about 2 kw.-years per metric ton of combined nitrogen. This figure is inclusive of the requirements of the carbide stage, nitrogen plant, the cyanamide furnace and all the necessary crushing and grinding plant. Abundant supplies of raw materials are required for this process, and are available in the United Kingdom, and the cost of materials delivered at a favourably situated factory should not exceed 16s. per metric ton for anthracite and 5s. per metric ton for lime. The quantities required for the production of a metric ton of cyanamide amount to from 450 kg. to 500 kg. of anthracite, and from 700 kg. to 750 kg. of lime, according to the manufacturing practice adopted. The total capital outlay required for a large single cyanamide factory under British conditions would amount to about £45 per metric ton of combined nitrogen per annum. Of this sum the carbide and cyanamide installation would require about £25 and the steam power section about £20.

The estimated production cost at the factory with electrical energy at £3·75 per kilowatt-year would amount to about £24 per metric ton fixed nitrogen in the form of raw cyanamide. Even when adding to the cost of the treatment of the raw product the charges for interest, &c., there is still a substantial margin as compared with the pre-war market price of fixed nitrogen in the form of Chili nitrate and ammonium sulphate. The advantage of this process is its adaptability for the manufacture of calcium carbide as an intermediate product. The demand for this is steadily increasing, and provides a ready, though indirect, method of obtaining ammonia by the fixation of atmospheric nitrogen, on account of the facility with which the cyanamide can be decomposed and used as combined nitrogen in the form of ammonia. The total capital cost under British conditions of a complete carbide cyanamide and ammonia factory of large size will amount to about £54 per metric ton of ammonia nitrogen per annum, and upon the basis of electrical energy at £3 75 per kilowatt-year, the production cost of pure ammonia liquor and of ammonium sulphate would amount to about £29 and £38 per metric ton respectively of combined nitrogen.

Making allowance for further charges these figures still show a considerable margin over the pre-war market prices of the corresponding form of combined nitrogen, while they also reveal the fact that the extra capital and working expenses required for producing pure strong ammonia on a large scale are by no means inconsiderable. As regards calcium carbide the power requirements per metric ton are somewhat less than 0·5 kw.-year, and the production cost would, therefore, amount to about £5 per metric ton, with electrical energy at £3·75 per kilowatt-year. The capital outlay for a large scale carbide factory with a steam turbo-electric power station would be of the order of £8 to £9 per metric ton of carbide per annum.

It would, therefore, appear that the higher cost of electrical energy under British conditions, although an important factor from the point of view of foreign competition, is to a large extent off-set by other favourable factors, such as cheap and abundant raw materials and the elimination of sea freights. There seems no reason why the manufacture both of carbide and of calcium cyanamide if laid out on a large scale should not be successful in this country. There are blocks of undeveloped water-power in Scotland of sufficient size for the operation of a large factory.

THE HABER PROCESS.

In considering the Haber process, the commercial development of which has been entirely confined to Germany, the Committee come to the conclusion that this can produce a marketable form of combined nitrogen at a cost about equal to that of the calcium cyanamide process, utilising energy at £3 75 per kilowatt-year, although the latter process shows an advantage when cheaper water-power is available. On account of the purity of the synthetic ammonia the Haber process is especially suitable for use in conjunction with the ammonia oxygen process for the manufacture of nitric acid and ammonia nitrate.

In considering the ammonia-oxygen process, which held a position of vital importance in Germany, and constituted practically the only method of obtaining nitric acid for military requirements in this country during the war, it is pointed out that the experience gained with the converters using platinum gauze as a catalyst is of too recent date to enable questions as to plant and methods of working to be definitely settled. The principal characteristics of the process are small power requirements, even when electrically-heated platinum gauze is employed as a catalyst, the necessity if high overall efficiency is to be secured for a comparatively large recovery plant when water absorption is employed, the moderate capital and working costs of the latest types of plant, and the adaptability of the process for manufacturing nitrates such as ammonium nitrate. The power required in this process is mainly for driving fans, blowers and pumps, and the power requirements would be about 0·08 kw.-year per metric ton of combined nitrogen.

ECONOMIES OF EXISTING PROCESSES SUMMARISED.

The evidence dealing with the economies of the established synthetic and non-synthetic processes may be summarised in the following conclusions: (*a*) A metric ton of nitrogen gas can be separated from the air by modern liquefaction processes for less than £1. (*b*) The market price of a metric ton of *combined* nitrogen in the United Kingdom prior to the war varied from £66 to £67 (in the forms of ammonium sulphate and Chili nitrate respectively). (*c*) The various synthetic processes can produce a metric ton of combined nitrogen at a cost, at the factory, of from £20 to £30. (*d*) The lowest recorded market price in the United Kingdom for a metric ton of combined nitrogen (as ammonium sulphate) was £35 8s in 1897. (*e*) The synthetic processes can produce a metric ton of *concentrated* (93 to 96 per cent.) nitric acid for about half the cost by the Chili nitrate retort process. (*f*) The synthetic processes can produce a metric ton of combined nitrogen ready for the fertiliser market, as cyanamide (nitrolim) or ammonium sulphate, at a cost at the factory of about or even less than one half the *pre-war market price* of combined nitrogen in the United Kingdom. (*g*) The synthetic processes, with the exception of the arc process under favourable conditions as regards cheap water-power, are not in a position to produce *nitrate* fertilisers at a sufficiently low cost to face the possible competition of Chili nitrate. This position may, however, be altered by the development of more economical methods of recovering oxides of nitrogen in the form of nitrate salts. (*h*) The capital expenditure for installing the synthetic processes is not excessive, being somewhat less than, or on a parity with, the pre-war market value of the annual production, except in the case of the arc process, for which the outlay is nearly twice the market value of the annual production. (*i*) The facility with which oxygen and the rare gases of the atmosphere can be obtained as by-products in the manufacture of cyanamide and synthetic ammonia is an asset in favour of these processes for British conditions on account of the fact that several important industries would derive a substantial advantage from the marketing of additional supplies of these gases at reasonable prices. The relative merits of the processes themselves, however, would probably not be affected by the prices obtainable for the by-products

Two of the partly-developed processes reviewed represent attempts to manufacture nitric acid from the air by the aid of fuel instead of electricity, and the other two are ammonia-producing processes. The primary products of the former consist of oxides of nitrogen in such a dilute form that a very large plant is essential for their efficient recovery as long as the present system of water absorption has to be relied upon. The primary products yielded by the latter are solid, but it is necessary to submit them to further treatment in order to obtain a marketable form of combined nitrogen. In all these methods of fixing nitrogen, difficulties have been encountered owing to the elevated temperatures required, but there is no reason to anticipate that they will not eventually be overcome. The cyanide processes are further handicapped by the properties and characteristics of the raw materials and crude products, but the Committee has been informed on good authority that most of the consequent difficulties have already been surmounted in the course of recent investigations carried out in this country.

After careful consideration of the relative merits and possibilities of the above processes from the standpoint of British conditions, the Committee has come to the conclusion that the modified Hausser process, whereby power and nitric acid can be obtained simultaneously, and the cyanide processes for the production of synthetic ammonia are the most promising of the partly developed methods of fixing nitrogen, and are well worthy of a trial.

FUTURE DEVELOPMENTS.

With reference to future developments in nitrogen fixation, it is probable that the prospects will be more favourable for ammonia-producing processes than for direct nitric acid processes, on account of the relatively small demand for nitric nitrogen under normal conditions, and of the facility with which it can be obtained from ammonia nitrogen by recent methods of catalytic oxidation.

THE RESEARCH WORK UNDERTAKEN.

The Committee were required by their terms of reference to carry out experimental work to arrive at definite conclusions as to the practicability and efficiency of processes. It was decided that experimental work should be concentrated upon the problem of the synthesis and oxidation of ammonia, as it was felt that the results obtained might prove of special value during the course of the war. Dr. J. A. Harker, O.B.E., F.R.S., was appointed director of research to deal with this part of the work, and devoted the whole of his time to the acquisition of equipment and staffing of the research laboratory. Accommodation for this purpose was obtained at the University of King's College, London, and a beginning was made during the summer of 1916 with a systematic study of the chemistry of the synthetic ammonia process. The process was first investigated on a laboratory scale, when some of the more important matters dealt with were the efficiency and behaviour of numerous patented and other catalysts with a view to the selection of those best suited for technical use; the determination of the conditions of temperature, pressure and gas velocity for the best yields of ammonia; the effect of impurities liable to occur in catalytic substances and in the gases themselves, and the methods for the removal of such impurities; the revivification of catalysts, the activities of which had become impure during use; methods for the removal of ammonia produced during the synthesis, and an examination of the problems involved in the circulation of gases at high pressures and velocities, including the study of heat insulation and of thermal exchange between current and heated gases. It was realised that the technical success of an ammonia process depended essentially upon the cost and quality of the hydrogen available, and that it would, therefore, be necessary to find a method of manufacturing a pure gas at a cost much lower than that of any hydrogen produced commercially in this country. A separate branch of the research was therefore constituted to go into this question.

With regard to the oxidation of ammonia, an investigation was instituted to cover the following fields of inquiry: The most suitable catalytic materials for the combustion of gaseous ammonia with air or oxygen, the design of converters suitable for technical use, and an investigation of their efficiency, output and general behaviour under widely differing conditions. The reaction kinetics of the oxidation process as a whole, including the absorption of oxides and nitrogen by water and tower systems, and the production of strong nitric acid, the absorption of nitric and oxidation by solvents other than water, the proportion of nitrates and oxides of nitrogen by dry and wet absorption processes and the direct proportion of ammonium nitrate from oxides of nitrogen were also examined. A physical section was formed to deal with a number of physical problems rising out of the main researches, and the work of this section has been published by H.M. Stationery Office in a pamphlet entitled "Physical and Chemical Data of Nitrogen Fixation."

Work in the Ammonia Section.

In the synthetic ammonia section about 200 catalysts were investigated, and a limited number of these were selected for further study. The highest yields given in technical literature were equivalent to from 0·25 kg. to 1 kg. of ammonia per hour per litre of space occupied by the catalyst. It was found as a result of these experiments that, with a given catalytic substance and a high velocity of circulation, yields equivalent to from 10 kg. to 20 kg. of ammonia per hour per litre of catalyst space can be obtained without difficulty at working pressures ranging from 100 to 150 atmospheres. To discover how far these small scale experiments would be confirmed in larger apparatus, a plant was constructed having a catalyst space of about 600 times the size of that in the original laboratory apparatus. The results obtained from this unit served to confirm those in the earlier work, and further experiments were then conducted in a full size commercial unit, with a catalyst space about 40 times that of the semi-technical unit.

In the hydrogen section the work, although primarily undertaken in connection with the synthetic ammonia process, is of interest owing to the enormous scale upon which hydrogen is now manufactured for the hydrogenation of fats and oils. A large apparatus capable of producing about 200 ft. of hydrogen per hour, the gas to contain less than 0·05 per cent. of carbon monoxide, was built; but further work in this direction was not carried out owing to the staff being required for other purposes. The research upon the synthesis of ammonia, however, pointed to the conclusion that its ultimate commercial success would involve the use of hydrogen containing a maximum of 0·05 per cent. of carbon monoxide and less than one part of hydrogen compounds in a million of gas. The advantages and disadvantages of the various methods for the elimination of these impurities were further thoroughly examined. Of these problems, the most formidable is the elimination of small quantities of carbon monoxide, and the method was discovered for effecting the removal of this gas at high rates of gas flow, and the small scale experiments were so successful that arrangements were made for a trial on a much larger scale. The operations were carried out at a works where commercial hydrogen containing from 2 to 4 per cent. of carbon monoxide was available, and afterwards at a second works where there was a supply of hydrogen containing about 0·25 per cent. of carbon monoxide. In full sets of trials, quantities of gas ranging up to 200 cubic ft. per hour were, therefore, handled satisfactorily. A combination process involving thermal combustion was elaborated which depended on the fact that complete oxidation of carbon monoxide could be effected catalytically at quite low temperatures. The purified gas obtained during trials of several weeks with this apparatus showed consistently less than 0·5 of carbon monoxide.

In considering the ammonia oxidation of nitrate processes, comparisons were made between converters with electrically heated nets and converters in which the temperature of the net was automatically maintained by the heat evolved in the process of oxidation. It was established that the best yield was obtained when using two or more nets, and that a distinctly higher converter efficiency could be obtained at rapid rates of gas flow when the net was electrically heated. This type of apparatus is also more convenient to control. On the basis of the above work, double net converters of simple design were eventually evolved, and their working efficiency was found to approach 98 per cent. At the maximum rate of gas flow the output of the apparatus was very high, amounting to 1·5 metric tons of nitric acid per square foot of double net for 24 hours.

The Effect of the War on the Industry.

From a general review of the war aspects of the nitrogen problems, a number of important deductions are drawn by the Committee. These, it should be pointed out, were made during the war. In the event of reliance being placed upon the retort process for meeting the war demands, the country must be prepared to face a heavy demand for shipping accommodation, resulting in a large advance in the price of raw materials and in the cost of products manufactured from them. These advances in price would be largely attributable to the necessity for importing essential raw materials, and of the total expenditure incurred a large proportion would represent payments contracted at a time when the rate of exchange was adverse. Only a small proportion of the retort process plant can be used under peace conditions on account of the great disparity between war and peace demand for nitric acid. Two years' expenditure upon imported raw materials at war prices would alone more than cover the estimated pre-war capital outlay for synthetic installations capable of furnishing the same output. In the event of reliance being placed upon synthetic methods the country must be prepared to face a large initial capital outlay; but the advances in the price of materials and in manufacturing costs would be covered by internal conditions only. On account, however, of the substantial advantage obtained by synthetic methods an all-round increase of even 50 per cent. in the estimated pre-war production costs would still leave them equal to the pre-war costs by the retort process. A large proportion of the synthetic plant can be used under peace conditions for the manufacture of fertilisers, while a saving in running costs for a period of two years would probably cover the initial capital outlay. There are, however, serious risks involved in relying upon overseas shipments of raw material, while the nitrogen fixation process is thoroughly reliable, even when installed under emergency war conditions. It therefore seems evident to the Committee that the country should resort to the policy of adopting synthetic methods as an insurance against future emergencies, instead of placing reliance upon Chile nitrate.

A Consideration of Post-War Aspects.

In considering certain post-war aspects of the nitrogen development, the Committee point out that the post-war supply of fixed nitrogen potentially available for the world's requirements is likely to be about one million metric tons per annum, while, great though the extension of the nitrogen fixation industry has been, it is not more than keeping pace with the rate of growth in consumption prevailing in the pre-war period. The demand for nitrogenous fertilisers is already considerably in excess of pre-war consumption, and the demands would increase if the price of fixed nitrogen fell to, say, £40 or £45 per ton. There will probably be an ample demand for all forms of nitrogenous fertilisers. The industrial demand for "nitric nitrogen" is likely to be met in future by means of synthetic processes which compare favourably with the Chile nitrate retort process. The producers of combined nitrogen may eventually have to face the competitive price of, perhaps, £7 to £8 per metric ton for ammonium sulphate and £6 to £7 per ton for cyanamide. The Chile nitrate industry, in order to hold its position against the cheapest synthetic fertilisers, may have to make a substantial reduction in price. With regard to nitrate fertilisers, the Chile industry will probably be able to hold the market against the synthetic processes. The by-product ammonia industry may be faced with the necessity of making substantial reductions in the price of sulphate.

As regards the post-war requirements of the United Kingdom, this country has hitherto depended entirely upon imported productions for all requirements in respect of cyanamide, "nitric nitrogen," and cyanamide. There is no question that the manufacture of cyanamide and "nitric nitrogen" can be established in this country on a sound economic basis, but the position as regards "nitrate nitrogen" is less certain. Given a sufficiently cheap supply of ammonia, synthetic nitrates can be produced at a price comparable with that of the pre-war price of Chile nitrate. At the expense of the export trade, the maintenance of the annual home consumption production equivalent to that in 1917 would be sufficient to render the United Kingdom self-supporting to the extent of the estimated demands on the conclusion of peace. This would have to be augmented to deal with the estimated possible demand in the near future. It is important to notice that in this case there would be no margin of production capacity for meeting a war emergency demand, and it would be unsafe to face the future emergency without a substantial reserve of plant capacity. From this point of view, maintenance of a large export trade in nitrogenous fertilisers would thus have to be an essential feature of post-war policy, since only in this manner could an economic use be found during peace time for an adequate reserve of plant. In order to render the United Kingdom independent of imported nitrogen products, the present scale of production would require to be largely augmented. A minimum increase on the present output can be looked for only in the case of gas works and producer gas works, owing to the removal of temporary restrictions on the manufacture of ammonium sulphate. In view, however, of the steadily increasing demands for all classes of fuel products for by-products, such as benzol, the by-product ammonia industries may be expected to make further large productions of fixed nitrogen in the course of a period of years, while low-temperature carbonisation cannot be disregarded as a potential factor in the nitrogen situation. Little or no reliance can be placed on peat and sewage for marketable nitrogen compounds.

Statistics show that the actual and potential resources of by-product nitrogen in the United Kingdom are adequate for meeting a demand of almost any magnitude. It does not follow that it would be a sound policy to place entire reliance upon these resources if it were decided to aim at the ultimate independence of external supplies of nitrogen products. Some successful method for utilising some of the potential resources still remains to be devised, and a serious practical objection to the nitrogen supply from by-product recover processes is the enormous tonnage of material that has to be handled to obtain a substantial output of "ammonia nitrogen." Probably one-third of the ultimate home production of "ammonium nitrogen" would require to be converted into "nitrate" or "nitric nitrogen" to meet the demands of agriculture and industry, and such demands can be met more economically by synthetic methods than by the oxidation of by-product ammonia. It would, therefore, be clearly a sounder policy from all points of view to take advantage of the modern methods in nitrogen fixation and to reserve sufficient to meet such large requirements, than to place entire reliance upon by-product ammonia, and the best policy would be one directed towards ultimate independence of imported nitrogen products to the establishment of nitrogen fixation on a large scale.

The Committee is satisfied that synthetic processes can at the present time be operated in the United Kingdom upon a sound economic basis. As regards nitrogen fixation in the British Empire generally, the ideal policy would be to make the British Empire independent of external supplies of all nitrogen products, and the investigations of the Committee show that this is practicable. Canada, for instance, possesses exceptional water-power resources capable of easy development at a cost probably as low or even lower than that of the very cheapest Norwegian powers, while in New Zealand, Tasmania, Egypt and India the method of synthetic nitrogen products can be profitably undertaken. In places where very cheap power can be developed, nitrate fertilisers might be manufactured at a price that would compete with that of Chile nitrate, while in other places where high-grade limestone and anthracite could be obtained the calcium cyanamide process might prove the best. It may be recalled that there are, however, large deposits of low grade coal in various parts of the Empire which could be cheaply mined, and constitute potential reserves of ammonia nitrogen, although the coal itself would not stand the cost of transport. The same consideration would apply to more valuable products, such as ammonium sulphate.

In the light of lessons recently learned, it is hardly too strong to state that this country cannot afford the risk of dependence upon Chile in future, and in this connection it must be observed that it would have been of enormous advantage to the United Kingdom and the Allies during the war if nitrogen fixation installations had been in force on a substantial scale on the eastern seaboard of Canada.

Transformers for Electric Furnaces.*

By J. L. THOMPSON, M.Sc.

It is the author's intention in this Paper to deal with the following points in connection with transformers for electric furnaces:—Requirements for useful service, construction and electrical features, future requirements, design of large furnace transformers, the ideal furnace transformer, mechanical stresses, furnace lay-out, cost and weight.

Types of electric furnaces in commercial use may be classified thus:—

(1) Arc furnace	Radiation type for steel.
(2) Arc furnace	Conduction type for steel.
(3) Induction type	For steel.
(4) Resistance type	For carbide, carborundum and ferro-silicon.

With types (1), (2) and (4), transformers are nearly always required; type (3) is in itself a static transformer. The induction furnace has several disadvantages, including a low power-factor, and has made little progress during the last 10 years.

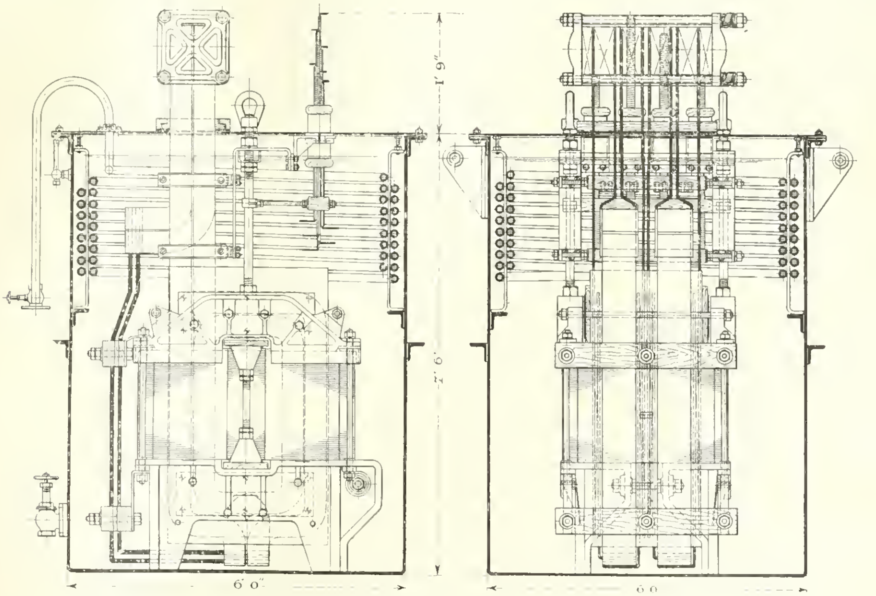

Fig. 1.—1,250 k.v.a. Single-phase Shell-type Furnace Transformer, arranged with Half-turns on Low-tension Winding.

With both types of furnace, transformers are in general use and must be of substantial construction.

Early troubles with transformers included:

1. Loss of low-pressure voltage across the arc due to bad lay-out of leads, or too high reactances of transformers.

2. Failure of insulation of switchgear and transformer terminals on the high-pressure side.

3. Mechanical damage to transformer coils due to current rushes.

4. Unbalanced voltages on the low-pressure side of Scott-connected transformers due to unscientific design.

5. Failure of transformers due to bad housing, unskilled operation and heavy overloads.

The above causes of trouble have now been practically eliminated.

Transformers for Steel Furnaces.

The requirement of steel furnaces may be for single, two or three-phase supply, but the general characteristics of the transformers are the same.

Voltage Ratio.—Furnaces in general require a minimum of three low-tension pressures for use at different stages of production.

Reactance.—Transformers must be provided with enough reactance (either internal or external) to steady the arc and reduce the rush of current to save values.

End Turns and Tappings.—The end turns of the high-pressure windings must be reinforced and extra insulation between the remaining turns is advisable. Tappings for voltage variation should be on the high-pressure side. On the low-pressure side correct voltages cannot readily be obtained, owing to the small number of turns.

The switchgear problem is also simplified by the use of high-pressure tappings, which should be in the middle of the winding.

Ratio of Iron to Copper Loss.—The ratio of iron to copper loss is not important, as transformers are never run for any length of time on open circuit. The total losses should be a minimum at the usual voltage.

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* Abstract of Paper read before the Institution of Electrical Engineers.

Circulating Currents. Coils connected in parallel should be so placed that they are equally loaded under all conditions of service.

Mechanical and Constructional Requirements.

The transformer must be of sound mechanical construction with its coils rigidly supported in all directions in which movement is possible under a heavy rush of current. All leads, high and low pressure, should be securely clamped to prevent movement due to heavy current rushes. The insulating material should be strong and firmly held in position, being assembled with the coils and secured while under pressure. Numerous ventilating ducts should be provided by means of suitably arranged spacing blocks between the several coils to prevent local heating. These ducts should ensure a free and ample circulation of the cooling medium. Only the high-pressure leads required should be brought out of the case. High-pressure line leads should be brought through individual insulators. The low-pressure leads should be increased in section, from 2 in. to 3 in. under oil level, to prevent heating.

Self-cooled transformers should be placed in well-ventilated chambers with a minimum distance between them of 18 in. for sizes up to 1,000 k.v.a. and 24 in. for large units. They should be kept clean and easy of access, and should be placed as near to the furnace as possible and symmetrical, with a fireproof barrier between them and the furnace. The operation should be supervised by a skilled attendant. Low-pressure leads should be as near together as possible, and interleaved for currents higher than 5,000 amperes.

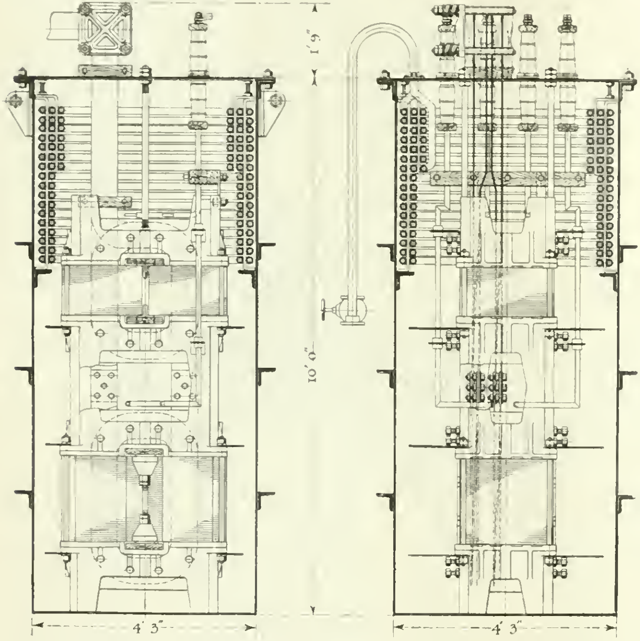


Fig. 2.—1,250 k.v.a. Single-phase Shell-type Furnace Transformer with Low-tension Booster.

Core and Shell Type of Construction.

Transformers for furnace work are manufactured of both the core and shell-type constructions.

The author, in his original Paper, shows typical examples of both, and discusses the relative advantages of the two types in some detail. Among the points dealt with may be mentioned accessibility and visibility of coils, shrinkage of insulation, arrangement of coil supports and nature of stresses, convenience in assembling leads. Most of these problems have been recently dealt with in discussions reported in this journal.

Future Requirements.

Up to the present time, electric steel furnaces have been designed and built for dealing with quantities up to about 15 tons, but the future will demand larger sizes up to 30 or 40 tons' capacity. Assuming 200 k.v.a. required per ton, transformer groups of 6,000 k.v.a. to 8,000 k.v.a. will be required. Transformers of much larger capacities have been manufactured, but the problem is complicated by the low voltages and heavy currents required.

This increased power can be supplied to the furnace :

1. By increasing the current at the present voltage.
2. By increasing the voltage.
3. By increasing the number of phases.

1. The total currents at the present voltage values may be increased and subdivided into two or more parallel paths, through the furnace. Thus in an 8,000 k.v.a. furnace at 85 volts to the bath, over 47,000 amperes per phase for a two-phase, and over 31,000 amperes for a three-phase furnace will be required.

Since the largest electrode at present in use is the 12 in. diameter graphite, capable of dealing with 11,000 amperes, it would be necessary to use at least four electrodes per phase for a two-phase, and three per phase for a three-phase furnace, *i.e.*, eight or nine electrodes for the furnace.

2. Power can be increased by raising the voltage between the electrode and the bath or, in other words, by increasing the intensity of the arc if the roof lining of the furnace permits. Here, again, is a problem for the furnace designer, as the transformers present no difficulties.

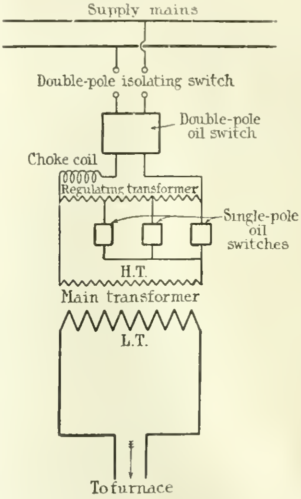


Fig. 3. Diagram of Connections of Furnace Transformer with High-tension Auto-regulating Transformer and External Reactance.

3. The third alternative, that of increasing the number of phases, seems to be favoured by designers. In this country the maximum number of phases used in a steel furnace has been three. Furnaces for four, six and eight phases have been designed, but there has been no commercial trial up to the present. Here, again, a large number of electrodes are required.

The practical limit of size for an electric furnace will depend on—

(*a*) The maximum current that can possibly be carried per electrode.

(*b*) The maximum voltage that can be sustained across the arc without destroying the roof.

(*c*) The maximum number of electrodes that can be installed without danger to the roof.

Thus, if 11,000 amperes is the maximum current per electrode, the maximum voltage across the arc 90 volts, and the maximum number of electrodes 8, then the maximum size of furnace is 7,920 k.v.a., or approximate 10 tons.

The Design of Large Furnace Transformers.

Owing to the large currents, special reactance and possible intricate connections, special design is needed. The reactance fixes the number of groups of coils, and the current determines the arrangement of the low-pressure parallel turns. For equal loading conductors in parallel must be of equal length and equal reactance. Several conductors have to be used in parallel per coil, and the choice of the number of low-pressure turns often lies between one and two. If $1\frac{1}{2}$ turns be used a proportion of active material nearest to the economical value can be obtained (*see* Fig. 1). High-pressure windings do not require so much thought, as they can usually be arranged in series.

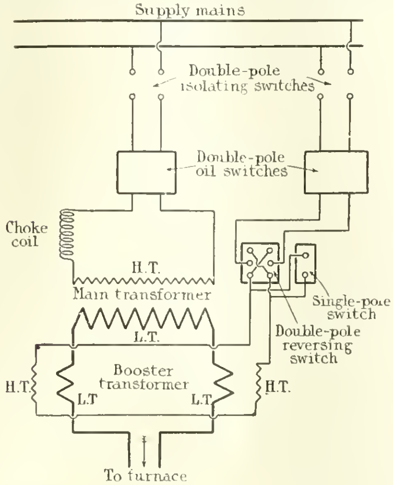


FIG. 4.—DIAGRAM OF CONNECTIONS OF A FURNACE TRANSFORMER WITH LOW-TENSION BOOSTER AND EXTERNAL REACTANCE.

THE IDEAL FURNACE TRANSFORMER.

The ideal furnace transformer must fulfil the following requirements:—

Simplicity in design and operation.
Reliability.
Balanced loading under all service conditions.
Safety and continuity of supply.

In order to simplify design and manufacture it is desirable to increase the number of low-pressure coils in parallel, which would have to be supplemented by an external reactance in either the high-pressure or low-pressure side. An ideal transformer would also be as simple as possible, having no tappings.

Voltage variation on the low-pressure side would be obtained by means of a regulating transformer (Fig. 3), a booster (Figs. 2 and 4) or an induction regulator. The regulating transformer may be an auto or double-wound transformer. If a booster is used, its primary winding can be arranged for the line voltage; hence no tappings are required if only three voltage variations are necessary. The three voltages can be obtained by using the booster positive or negative and by short-circuiting the booster primary winding. The use of a regulating transformer, booster transformer, or induction regulator makes possible the same loading condition of the low-pressure coils at each voltage. The reactance being external can be varied at will to suit all furnaces. External reactance in the line leads of the high-pressure side will also protect the transformer from voltage surges. Since many furnace transformer failures are due to faulty insulation of tappings, the abandonment of tappings on the main transformer will increase its reliability.

With the suggested methods of voltage variation tappings are sometimes unavoidable, but should the auxiliary units fail one can cut them out and continue running the furnace from the main transformer at some voltage. The voltage obtainable, if not that for most economical production, will be serviceable and prevent a complete shut down of the plant.

(*To be concluded.*)

The Annual Physical Society and Optical Society Exhibition.

(*Continued from page 93.*)

MARCONI COMPANY.

In the exhibit of the MARCONI COMPANY we noticed a new hot wire instrument of considerable interest. This is shown diagrammatically in Fig. 13, in which most of the detail is omitted for the sake of clearness. The instrument (which is due to Mr. Ewen of the Marconi Company) depends upon the expansion of a wire when heated by the current, but in place of a single wire exerting a pull in the middle of the heated wire, there is a bifilar arrangement which is maintained in tension by the controlling spring of the pointer; consequently, when the heated wire sags, the pointer moves round. In the diagram *A*, *B* is the heated wire; *C D*, the bifilar control. Such an arrangement presents a nice straightforward method. There is a further interesting point in the design that the whole movement can be easily removed. The circuit in which it is desired to measure the current is introduced as the primary of a transformer by the terminals *EF*. The secondary is included in an ebonite block *K*, and this carries the whole of the movement. Zero adjustment is effected by giving rotation to this block one way or the other, and if it is moved round sufficiently past the zero the transformer part can be lifted up and the whole withdrawn, as the card is slotted to allow the needle to pass through it; consequently, if there is any mishap, a new secondary, complete with movement, can be quickly replaced, or one can be inserted with a different sensitivity or different coupling.

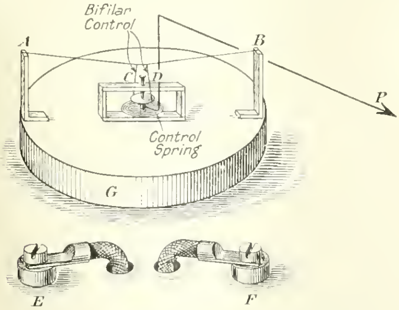


FIG. 13.—HOT-WIRE AMMETER FOR H T. CURRENTS.

ISENTHAL & COMPANY.

Besides a number of rheostats of the type familiar to our readers, Messrs. ISENTHAL exhibited a variable condenser due to Mr. F. J. Chambers (and known as Chambers' "Phantom" Condenser) for use on wireless telegraph circuits. The object has been to produce a serviceable type of variable condenser with an accurate scale, calibrated in terms of wave length, which can be corrected with facility for the effective capacity of any circuit in which it is likely to be employed. It is of prime importance that a variable condenser should be screened so that its effective capacity is unchanged by the approach of conductors or by the vicinity of the user. This is carried out in the "Phantom" Condenser by completely enclosing the plates in a metal case, the moving sets of plates being connected permanently to the box. Any screening arrangement necessarily introduces a certain capacitance from one set of plates to the other through the screening medium. But if the moving plates are connected to the screen, this error is a constant quantity and can be corrected by a permanent adjustment. A further error in all condensers is due to the linking electrostatic field between the outside plates. This is reduced to a negligible quantity by employing a total plate area which is large compared with the area of a single plate. Another well-known error is due to the additional capacity introduced by the plate edges. In the "Phantom" Condenser this error is reduced to a minimum by the use of extremely thin metal plates, and by the fact that, owing to the shape of the plates, the edge area is always maintained small in relation to the effective capacity of the instrument on any setting. These errors all tend to increase on the lower settings of a variable condenser, and it is obviously impracticable to design a screened instrument which reads correctly to zero. The aim in the present instrument has therefore been to produce a condenser with a wide range of capacity, and possessing uniform accuracy over the whole range.

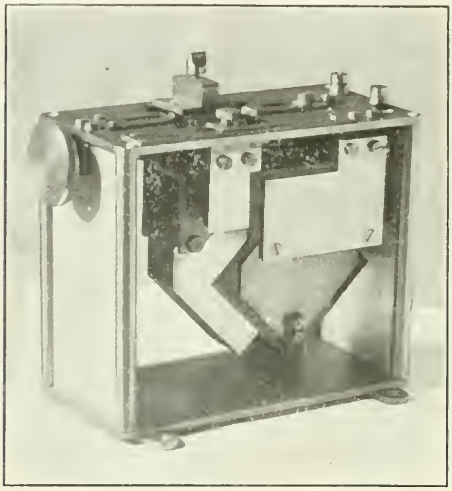


FIG. 14.—CHAMBERS' "PHANTOM" CONDENSER.

The instrument consists of a main condenser *A*, and a small "Phantom" condenser *B*, both variable and connected in parallel, as shown in the diagram above. The main condenser plates are square except for one corner of each plate, a small portion of which is cut off transversely to the diagonal. The plates are mounted in such a manner as to be adjustable along their concurrent diagonals, so that the area—and therefore the capacity—varies according to the square of the distance traversed by the moving plates, plus a constant due to leakage, and minus the absent area due to cut away portions. The "Phantom" condenser is normally set to correspond with the "absent" area, minus an area representing a capacity equivalent to the resultant leakage effect. After this latter adjustment has been made the effective capacity of the instrument varies accurately according to the square of the relative traverse of the plates along their diagonal. Square plates, traversed diagonally, were originally proposed by W. Tissot.

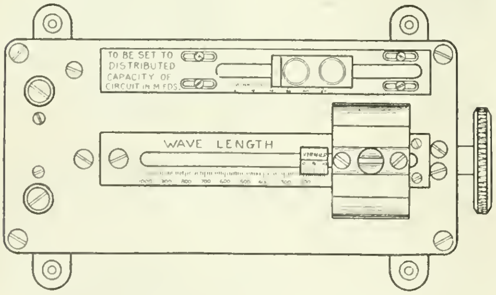


FIG. 15. ARRANGEMENT OF "PHANTOM" CONDENSER.

When the instrument is connected to an oscillatory circuit, a small substractive adjustment is made with the "phantom" plates in order to compensate for the distributed capacity of the coil or coils of the circuit. In this manner the accuracy of the scale is maintained under any conditions of service. In future instruments the "phantom" scale will be calibrated in micro-microfarads, the scale readings corresponding to the distributed capacity in whatever circuit it is intended to use the instrument. Once this capacity has been measured, or otherwise predetermined, it is only necessary to set the "phantom" pointer to the value obtained. The arrangement will be understood clearly on referring to Figs. 14 and 15. The accuracy is shown by Fig. 16, the curve being drawn from test results by the National Physical Laboratory.

The instfument illustrated is arranged for a rough straight adjustment, which can be changed to a fine spindle action by a single movement. It has a maximum capacity of approximately 2,500 micro-microfarads. A smaller condenser may be obtained which has an appropimate maximum capacity of 1,000 micro-microfarads and a high pitch spindle motion. The small type is suitable for station work, the whole scale being traversed by a few rotary movements of the spindle.

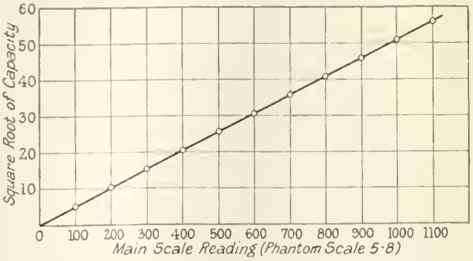


FIG. 16. ACCURACY CURVE OF "PHANTOM" CONDENSER.

WESTON ELECTRICAL INSTRUMENT COMPANY.

Among a beautiful selection of instruments by the Weston Electrical Company we noticed two which call for detailed comment.

Portable Microfaradmeter. By the first of these the engineer is now provided with a simple instrument for the direct measurement of capacity instead of relying upon the more indirect means which have hitherto been employed. The method adopted is shown diagrammatically in Fig. 17, from which it will be seen that there are two circuits. A source of alternating current is converted to *A*, *B* and the unknown condenser across *CD*. The instrument contains a known capacity *K* and an electrical system consisting of two fixed field coils together with two suspended coils at right angles to one another. The current through the capacity *K* passes through the field and moving coils all in series, and since the suspended system is not spring controlled it will take up a definite position (45° to to the left of the position indicated by the arrow, so that the pointer is at zero if no capacity is connected across *CD*). If now the condenser it is desired to measure is connected to *CD*, a current through the latter will pass through a second winding on the suspended coil and then through the field coils. This, of course, alters the direction of the field of the moving system and the needle is deflected.

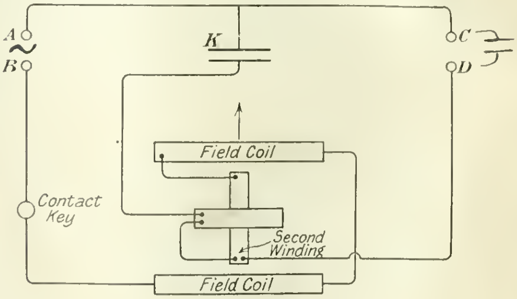


FIG. 17.—DIAGRAM OF PORTABLE MICROFARADMETER.

The constants of the instrument are so arranged that the ratio of the two currents flowing through the standard and the unknown condenser is substantially the same for any frequency and voltage over fairly wide limits, but for highly accurate work the voltage should not vary more than 15 per cent. above or below normal, or the frequency more than 10 per cent. As the instrument has no springs or similar controlling device the position of the pointer must depend solely upon the ratio of the current through the two circuits of the movable system, and as this ratio depends solely upon the capacity of the unknown condenser the instrument must accurately measure that capacity, and is guaranteed to do so within ½ per cent. of the maximum scale reading from 0·3 m.f.d. upwards or 1 per cent. for ranges lower than 0·3 m.f.d.

Being air damped the pointer quickly comes to rest so that measurements may be made with the same speed and facility as with other Weston Measuring Instruments. Indeed, with the microfaradmeter a large number of condensers may be measured in rapid succession in the same manner as dry cells may be tested with a cell-testing voltmeter.

A resistance (not shown in the sketch) is included in the circuit of the instrument, which will prevent an excessive current passing through it in case the binding posts C D, are short circuited. The ordinary supply circuit pressures are used.

THE FOSTER INSTRUMENT COMPANY.

We need scarcely remark that manufacturers constantly require information in regard to the quality of the materials they are using, and that the testing of materials is not always an easy matter. This is particularly true of steel and other metals, for although information of the greatest value is obtainable it is generally gained through the medium of expensive appliances. In the Humfrey Autographic Notched Bar Testing Machine a successful attempt is made to provide much useful information by comparatively cheap and simple means.

In this apparatus the standard test piece is similar to that used for single impact tests in the Charpy and Izod machines, namely 10mm. by 10mm. section with a round bottomed "V" notch at the region intended to be tested. It is convenient to cut several notches in a long specimen so that consecutive tests may be made, thus giving information as to variation in the bar and allowing average results to be calculated for the material under test.

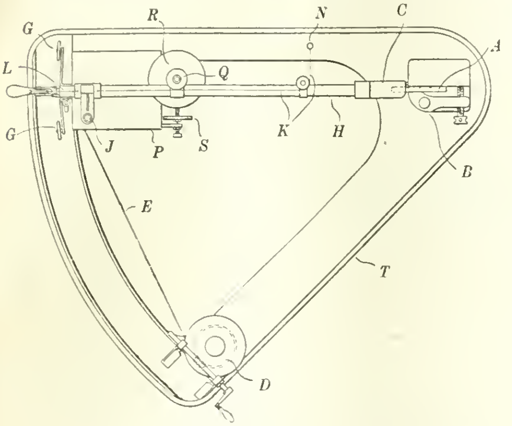


FIG. 18.—PLAN OF HUMPHREY'S NOTCHED BAR TESTING MACHINE.

In machines of the Charpy and Izod class, where the specimen is broken by the action of a falling weight, the test result indicating the energy absorbed in breaking the specimen gives no information as to the manner in which the specimen broke, that is to say, it is not shown quantitatively how far the specimen bent before actual fracture, or whether it was brittle or ductile. Obviously information of this kind is necessary for the classification of the material.

Having in mind this serious limitation of the existing machines, Mr. J. C. W. Humfrey designed the machine illustrated diagramatically in Fig. 18, and shown also in Fig. 19. The test piece A is gripped in the vice B, so that the jaws of the vice are in line with the notch in the test piece. The socket C is fitted on the projecting end of the test piece, and is a reasonably close fit thereon. A bending stress is applied to the test piece by means of the winch D and the wire E, which is attached to the outer end of a spring bar, the other end of the bar being firmly fixed to the socket C. The outer end is supported by two rollers G. This spring bar is not apparent in the diagram because it is directly below a rigid bar, marked H, which is also fixed to the socket C, and which carries the pen for the graphical record.

The deflection of the spring bar F is a measure of the bending moment applied to the test piece. Since the rigid bar H is not subjected to any bending moment it will move through the same angle as the socket C, and this movement will therefore be a measure of the bending of the test piece. The pen J slides upon the rigid bar H, its position being determined by the thin wires or cords K and L, which are kept taut by a light spring M. One end of the wire K is attached to a post N, so that as the rigid bar H moves in consequence of the bending of the test piece the wire K will draw the pen to the right. The point of the pen marks upon a calibrated chart P, which is carried on the spring bar F. Consequently, if the test piece offered no resistance whatever to the bending force the pen would draw a horizontal line on the chart, the length of which is proportional to the angle through which the test piece is bent. As, however, the test piece does offer resistance to bending there is a resulting movement between the spring bar F and the rigid bar H. On the other hand, if the test piece did not bend at all under the applied force the pen would draw a vertical arc on the chart, the height of this line representing the magnitude of the bending moment applied.

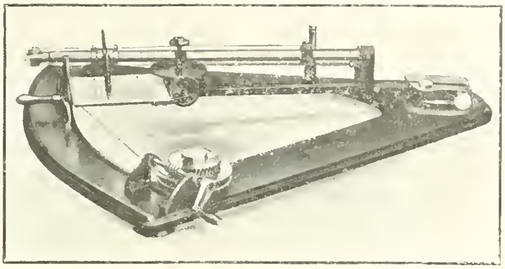


FIG. 19.—VIEW OF HUMFREY TESTING MACHINE.

Of course, in actual practice both of these effects are operative at the same time; the test piece offers resistance to bending, but is nevertheless bent as the force applied increases. The result is that the pen draws upon the chart a diagram or "graph" showing the relation between bending moment applied and the angle of bending throughout the duration of the test. Fig. 20 is such a record which was made during our inspection at the exhibition.

The total energy absorbed in the breaking of the test piece can, of course, be calculated easily from the diagram or graph. Alternatively, the machine may be fitted with an integrating device.

It will be evident at once that the information given by this machine is extremely valuable. It has, we are informed, been found in practice that the correct heat treatment of any material can be determined with ease by testing a series of test pieces, and steel which was perviously unreliable has been made to give quite satisfactory results on the basis of information yielded by this machine. Since the price is only £72 it is within the reach of all who require such information.

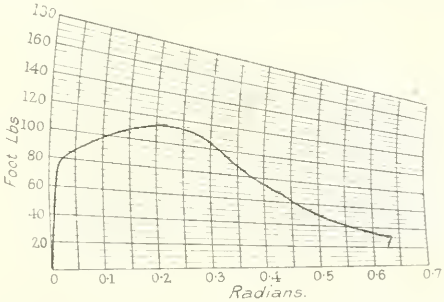


FIG. 20.—TYPICAL DIAGRAM FOR FOSTER TESTING MACHINE.

Pyro Millivoltmeters.—A line of particularly sensitive pivoted moving coil millivoltmeters has been developed, the range being from 2·5 millivolts and upwards. For use with standard thermo-couples they have a range from 18 millivolts and upwards. When so used they are provided with a rheostat for compensating for the resistance of the thermo-couple. The index of the rheostat is set to the valve nearest to the thermo-couple resistance; the total resistance is thus kept constant at the value for which the instrument is adjusted.

(*To be concluded.*)

Failures of Turbo-Generators and Suggestions for Improvements.

We give below an account of the discussion on Mr. J. Shepherd's Paper on "Failures of Turbo Generators and Suggestions for Improvements," which took place at a recent meeting of the Institution of Electrical Engineers in London.

Mr. A. B. Field said the manufacturers must admit that the author had good grounds for his indictment of most of the old machines. Many of the author's proposals pre-supposed improvements in insulating methods. He felt that big machines in which the cooling was effected by the intake and rejection of large volumes of air would be superseded. Perhaps, however, the author hardly appreciated the possibilities of water cooling a machine by circulating air through the machine and an air cooler incorporated in the machine. This overcame the difficulty of air ducts, air filtration, salt laden air and so on. The proposal to embed completely the winding of the stator throughout its whole turn had been kept in mind for many years, and he had described an attempt to effect this before the Institution a few years ago. But the real difficulty was in bringing earthed metal up against the coil throughout the entire turn. There were several places in the stator turn where the insulation could not be as good as in the top parts. At a junction between two types of insulation a considerable creepage distance must be allowed.

Mr. E. W. Dickinson took it that the Paper was intended to show that the water-cooled turbine generator would overcome all their difficulties. He was inclined to agree with the last speaker that it would be some time before they would get a water-cooled turbine that would run without breakdowns. He thought solid metal strips would have the same objections as binding wire. A solid end ring enclosing the end windings would be better, because if a short occurred internally in the rotor there would be no breaking up of the binding wire to contend with. He had found solid couplings better than flexible ones for large turbo generators. He had had the difficulty of loose core plates both in the middle and ends of coils, and that, like many of the difficulties the author mentioned, could be overcome by careful workmanship. He did not agree that the difficulties the author mentioned with regard to air-cooled turbines could not be overcome. He would not like to be the operating engineer in charge of a water-cooled turbine such as the author suggested, unless the insulation was covered with some material which would prevent the water from getting into it.

Mr. G. W. Partridge thought most of the author's faults of design had been taken in hand by the English contractors, and that the designs had been modified to meet them. The solid rotor was usually employed only for machines running at 3,000 r.p.m. and up to 12,000kw. A plated construction was advisable so that one could see inside the material more and know more of what was going on than was possible with a solid rotor. He was surprised by Mr. Shepherd's attack on the Parsons flexible coupling. The Germans had discarded it, but he preferred it for a large machine. The author had not mentioned the difficulty caused by the single-phase short circuit which often took place, burnt all the wedges in the rotor and often disturbed the windings and end connections. As regarded the reliability of the turbo-generator, he had experience of such plant amounting to between 30,000 and 40,000 kw. and with the most severe service in the country and short circuits numbering sometimes from 20 to 30 in a week, and up to the present he had been free from most of the faults of design and troubles referred to by the author. It was not always preferable to have iron or steel wire clamping at the end of the rotor. In some cases it was advisable to have bronze in certain parts of the rotor and steel in the rest. Water cooling would add to the expense. There would be the difficulty of deposit blocking up the channels, some of which were very small. He had had to have the coils of large transformers cleaned with hydrochloric acid. Another difficulty was keeping the water out of the end joints. After a few short circuits, with strong fields, they would rattle about. Also if the machines were not kept on constant load there would be serious trouble from condensation. Valuable space was taken up by the water ducts that might be used for air ducts.

Mr. A. M. Taylor ventured to suggest that as, in the near future, we were to have stations generating at 30,000 to 60,000 volts it was a question whether the transformers could not be efficiently used to improve the reliability of the generators. Suppose, for example, that instead of earthing one end of each generator coil, the coil were insulated at both ends and the two ends taken out to a corresponding coil on the primary of the transformer, and that the midpoint of this coil was earthed. We should then at once halve the potential stresses between any part of the generator winding and earth. The arrangement would really be the equivalent of six phases on the generator, though there would be only three coils, as at present. Suppose, further, that a second three coils of intermediate phase were added to the generator; then, for the same output, the voltage of all six coils could be again halved, thus quartering the stresses to earth. The second three coils would be connected to a second lot of primaries on a second transformer; and in order to rectify for the phase displacement the second transformer would have its high tension sides in delta, while that of the first transformer would be in star, both being coupled to the same bus bars. Besides quartering the stress to earth on the generator windings, the arrangement would have the decided advantage of reducing the tendency of the sound coils on the generator to pour current into the faulty coils, for, in the case of coils that are feeding into different transformers, there were two primary and two secondary reactances in series. He (the speaker) believed that when the great advantages of multiphase transmission were appreciated, this (multiphase) form of transmission would be adopted for all long-distance work.

Mr. W. McClelland (Director of Electrical Engineering to the Admiralty) said he was chiefly interested in the matter of the application of large turbo-generators for electric propulsion. It seemed to him that the author had not exaggerated the difficulties. They had heard from time to time that America had led the way in electrical propulsion, but the conditions there were more favourable for the use of electric propulsion, which was very economical, at cruising speed. At present we could not gain any advantage from the use of electrical propulsion at maximum speed, and he thought America had sacrificed maximum speed to gain the economy at cruising speed. The author said very large air tanks were necessary. Taking the American battle-cruiser, to which he referred, developing 180,000 h.p. the air tanks for circulating with the motors alone would be of an area of 275 sq. ft., or 19 ft. diameter if taken as a circular trunk. To get the motors as near the propellers as possible they must be placed aft, and to put an air trunk of 275 sq. ft. area aft would be impossible. He did not know whether the author could justify his remarks with regard to water-cooling apparatus, but the Paper was certainly an attempt to tackle at the source the difficulties of the use of turbo-generators for ship work.

Dr. S. P. Smith said the buyer in this country did not go for the best but the cheapest machine; and he got it and the troubles with it. There might be some machines that still had the troubles mentioned in the first part of the Paper, but manufacturers had long learnt to remedy many of the things mentioned. There were makers who did not trouble much about core-building, but surely they did not need to be told in 1920 how to build cores. If they were well punched and built and the keys were put in properly a high pressure could be put on them—100 to 200 tons—and they would still keep the solid construction, the lines would be very low and there would be no trouble with keys granted water was a better cooling medium than air, but the temperature of a winding often did not depend entirely on the cooling medium. It depended largely on the insulation. The iron of the rotor or stator might be got very cool, but the winding may be quite hot because the heat would not flow through the thick mica insulation without a considerable temperature resulting. He did not think the water cooling proposed would be a success. We had built good machines, and no doubt would continue to do so, but one did not know precisely what was taking place inside, and a little margin should be allowed.

Mr. F. H. Clough said the author had described many weaknesses, which were quite out of date and many which had never been committed. He was inconsistent in advocating low temperatures and yet advocating a type of a stator winding which would lead to a very high temperature. He thought the author was misled in his conception of the method of dealing with the forces that occurred on short circuit. One must consider what the forces were and where they originated, and try to eliminate those forces or reduce them so that they were innocuous. He welcomed operating engineers when they came to him to discuss the design of machines, and he thought that was how progress would be obtained. The author had attempted to give them a solution which perhaps many of them had already thought of, though they had had to be very careful, as the carrying out of such a suggestion depended on other things of which they were not quite sure. He thought it would be difficult to persuade the author to buy a machine such as he suggested. He did not think the picture was so bad as the author had painted it. The Company with which he (Mr. Clough) was associated made good all faults that occurred. He thought all the manufacturing companies did that—for which they set aside a sum of money. Though the percentage set aside was small a fund had accumulated. Possibly some form of water cooling might come eventually, but it should be only after very careful thought, otherwise it might introduce difficulties which did not exist at present, and which might be very serious.

The Author, in reply to the discussion, said his Paper was an attempt, from two points of view only, to see whether better machines could be built. Those two points were to get a safer and a cooler machine. Users as well as designers went to one fountain head for their knowledge, and that was the machine in operation. There were only two classes of machines—that which the salesmen described in beautiful language and that which you got. Every fault described in the Paper he had experienced. He suggested water cooling for giving greater support to the insulation. He found the insulation the seat of the greatest disasters. Therefore, he said, treat it with more respect. Mr. Field raised the question of getting insulated bars in close proximity to earthed metal, but they had that, whether they liked it or not, throughout the length of the slot. The bar should be made of such a form that the insulation should be carried throughout. So far as he knew, the A.E.G. discarded couplings ten years ago, but Brown, Boveri sometimes used them. He agreed that insulation should be used with a greater margin of safety. Some of the things he had mentioned might be out of date, but slack cores were not. He could mention certain machines which to-day were awaiting an opportunity of rebuilding.

Institution of Electrical Engineers' Visit to Holland.

A week or two ago we were able through the kindness of Mr. C. H. Wordingham to give an account of the recent visit paid by a deputation of the Institution of Electrical Engineers to Holland. Further photographs illustrating the development of electricity supply in that country have come to hand, and we reproduce a selection of these herewith. It will be remembered that the position of electricity supply throughout Holland is a very favourable one, and the development generally has been much facilitated by the adoption of a standard frequency of 50 cycles. Wayleaves are compulsory, and distribution is principally carried out by means of overhead wires for the lower pressures and to some extent for the higher. Generating stations of the various authorities have been, or are being, inter-connected to permit the concentration of generating plant in large units in suitably situated stations, and every effort is being made to cater for the needs not only of the towns for manufacturing industries therein, but of the rural districts. As is well-known in the past the pumping which is necessary in a large part of Holland has been carried out by windmills. This antiquated method is gradually being replaced by the electric drive.

The first of our illustrations shows the cooling towers at the Limburg State coal mines. Special attention may be called to the dice-box shape which is made of ferro-concrete. The cost of this form of erection at post-war prices is the same as with the older wooden form at pre-war prices. These coal fields, from which most of the home-produced fuel in Holland is obtained, have not up to now been sufficient to meet the needs of the country, but steps are being taken to increase the output, and with the economy effected by the generation of power in large stations, it is hoped that the coal may become practically self-supporting in this respect. Electrical winding gear employed at one of the mines is shown in Fig. 6. Fig. 2 shows an overhead 3,000-volt switch at a Friesland farm, and is typical of the construction followed in these instances, while Fig. 5 shows the construction employed where a 50,000-volt line crosses the railway. Figs. 3 and 4 are illustrative of the plant employed at the Amsterdam generating station. As mentioned in our previous account, this station is operated in conjunction with a central refuse destructor. At this destructor the whole of the refuse of the city is concentrated, and is unloaded at transporters and delivered to moving belts. A suitable portion of the refuse is used for generating steam, which is conveyed to the adjoining electricity station. During the war a considerable proportion of the output was generated from steam raised in this way.

Review.

Electric Mains and Distributing Systems. By J. R. Dick and F. Fernie. Second Edition. (London: Benn Brothers, Ltd.) Pp. x.—466. 18s. net.

After four and a half years' study of the art of war, it has been very refreshing to read the second edition of Messrs. Dick and Fernie's well-written book. The authors deal with the problem of distribution in a very comprehensive manner and, provided that the reader who may not have been able to keep up his knowledge of higher mathematics does not "get the wind up," but boldly takes some of the complicated formulæ for granted, he will obtain much valuable information, and possibly a good deal of pleasure, from the lucid manner in which the various problems are dealt with.

The chapters on alternating-current work particularly are extremely interesting, and in this edition have been added to and carefully rewritten. All the problems which have to be dealt with in the distribution, and some of those which might be considered to apply more to the generating side of electricity supply, receive attention. Fundamental formulæ are also given, so that the book forms a complete work on the subject, without the necessity of referring to any other text-book. The information now given on the temperature rise in cables, in Chapter VI. comprises as far as the writer is aware, all the knowledge that is at present available, but as the authors say on page 93, further experimental work on the heating of cables laid under ground is necessary. On the question of the regulation of pressure the authors suggest, more than once, that bus bars at the works should be run at different pressures, feeders being grouped according to the drop. This method of working has the serious disadvantage that the generating plant must be duplicated, resulting in inefficient working. The authors suggest that power and lighting networks should be separate, but with the development of cooking and heating, the lighting mains will have increasingly heavy loads to deal with if heating apparatus is connected to them, while if connected to a separate power network, on which as suggested by the authors, the voltage regulation need not be so accurate, complaints will undoubtedly be received from consumers who cannot get their ovens hot.

In Chapter IX., Part I., the authors do not mention that a great many balancing troubles can be got over by introducing automatic balancing sets at various points on the distributing network. These machines run from week end to week end without attention, and deal with practically all the out-of-balance current. In Part II. some very practical chapters are given on the laying and maintenance of distributing systems, including boxes and fittings. Troubles on mains vary largely according to locality, but in one town where continual difficulty was experienced with water getting into boxes, a very large improvement has been made by the use of the cast-lead box, mentioned on page 406. This box is inexpensive and the reliability is demonstrated by the figures given in the following table :—

(*Faults in a Low-tension Three-wire Network. January* 1, 1915, *to April* 30*th*, 1919 ; 4 *years* 4 *months*).

How discovered.	In disconnecting boxes.	In cast-iron service boxes.	In lead service boxes.	In cable.	Total.
Interruption to supply of a section..........................	5	25	2	6	38
Momentary short. No interruption	6	1	Nil.	Nil.	7
By "Megger" testing...........	5	32	7	13	57
By splitting, as described on page 341 of Dick and Fernie's book	1	7	1	4	13
No supply to consumer	Nil.	8	1	2	11
Continuity test	Nil.	2	Nil.	Nil.	2
	17	75	11	25	128

Notes.—Faults on cable were all due to mechanical damage after laying. All faults in disconnectng boxes causing shorts (11 in number) were due to condensation.

There were about 2,500 lead boxes in use, and 1,300 iron boxes, giving a precentage of failures per annum of 1·33 per cent. for iron, and 0·102 per cent. for lead boxes.

The table may also be of interest as showing the methods used to locate faults. The "Megger" in use works at a pressure of 1,000 volts, and many incipient faults have been found that could not be detected by other methods. For disconnecting boxes diving bell lids are, in the reviewer's opinion, essential to enable work to be carried out rapidly, while copper wire threaded through asbestos tubes has been found very satisfactory for distributor fuses. The reviewer does not agree with the suggestion made on page 81, that every length of distributor should be fused. Experience in the past has shown that these fuses are likely to blow when there is no necessity for it. The authors conclude their book with tables of costs, which, in view of present prices, do not appear to be very helpful, as the figures have not been altered from those given in the first edition.

The work is an extremely valuable one, written with first-hand knowledge, and brought up to date ; in future editions the authors might try to still further arrange the matter and the index, for the use of the engineer who wants to look up a particular problem, as undoubtedly the book will be retained close at hand by many supply men for this purpose.

W. A. Vignoles. Lt.-Col.

Correspondence.

WIRELESS STRAYS FROM THE UNKNOWN.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : I desire to protest against the interpretation that appears to have been put upon statements which I have made at intervals during the last few years with regard to the possible sources of what are being termed "mysterious messages from the unknown." Wireless messages are transmitted through the ether by the agency of electromagnetic waves of definite lengths which can be adjusted, and in order to receive such messages the receivers should be tuned to the particular wave-length that is being used for transmission.

At times signals are received which are apparently due to electromagnetic waves of great length (up to hundreds of miles), and these signals are not of the same character as those commonly called "X's" or "strays." Occasionally such signals can be imagined to correspond to the Morse signals for certain letters, and these signals occur at all seasons and irregularly.

The sources of such signals are unknown. They may be in the atmosphere or outside it, and due to electrical disturbances. If outside the atmosphere, they may arise in any point of interplanetary space, possibly in the sun, where it is well known that electrical disturbances occur.

Obviously, since the planet Mars is situated somewhere near in interplanetary space, the source of such signals might be on it or on any other planet. There is nothing, however, to show that this is the case, nor must any purely fanciful speculations of mine be interpreted to mean that I have asserted having received any intelligible or unintelligible messages from Mars or from any other point in space outside the earth.—I am, &c.,

London, Jan. 28. G. Marconi.

THE RECORDING OF FAILURES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : I have read with great interest your remarks on the "recording of failures" under the heading "Development of Heavy Electrical Machinery." It was never more obvious to electrical engineers than it is at the present that the utmost publicity should be given to the technical features of breakdowns of plant. In an article to the "Electrical Review" of September 20, 1918, p. 269, I advocated the publication of data of this sort, but without result. My own chief engineer, Mr. W. W. Lackie, of Glasgow Corporation electricity department, supports the scheme. In my opinion you would be doing the electrical supply industry a good service if you would initiate energetic propaganda with a view to making such publication compulsory. At the present time information regarding plant failures on large systems is only disseminated by what is little better than gossip, and the reputations of the engineers involved generally suffer far more in this way than would be the case if they made an open statement of the circumstances.

The amount of information gained from failures on high-tension systems is enormous, and it seems to me to be the last word in selfishness to hoard the results of what is often bitter experience rather than to put this experience freely before others and give them an opportunity of avoiding disaster.

America has led Britain in this respect, as is shown by the publicity given to breakdowns which occurred with large turbo units, but I hope you will endeavour to make our supply authorities realise their responsibilities still further.—I am, &c.,

Carluke, N.B., Jan. 19. Charles W. Marshall.

"THE IMPEDANCE PARADOX."

TO THE EDITOR OF THE ELECTRICIAN.

Sir : The phenomenon of the increase in the impedance of a circuit consisting of resistance and reactance in series produced by shunting the reactance was discussed and explained in The Electrician in 1910 by Campbell, Howe, Russell and Still (Vol. LXV., pp. 59, 113 and 157).

The special case explained by Mr. Clinker in one of your recent issues is especially striking, and is to me quite new, although we have exhibited the ordinary case of the impedance paradox at the Northampton Institute for the past 10 years. The arrangement we use is that of a glow lamp in series with a choking coil (or a condenser), the line current suffering reduction on shunting the coil with a second glow lamp.

I described a simple graphical method of solving the problem in an article in the "Electrical World" (New York) in May, 1910.

A concise way of stating what happens is to say that to shunt the reactance by an ohmic resistance improves the power factor of the system more than it increases the power absorbed.—I am, &c.,

London, Jan. 23. F. M. Denton.

The Electrician.
FRIDAY, JANUARY 30th, 1920.
Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

The Economics of Power Production.

The public has been allowed to suppose by our daily contemporaries and by the politicians that the first result of the Electricity (Supply) Act will be the erection of a number of so-called super-power stations, and that the erection of these power stations will mean cheaper electricity. To the initiated, however, it is obvious that the erection of super-power stations will not of itself create a load worthy of their size. The present demand must first be increased, and it will not be increased unless energy can be supplied at an attractively cheap rate. Now, in pre-war days, we used to talk optimistically of current at a half-penny per unit for domestic purposes: and though the realisation of that dream has been postponed by the general rise in prices, a careful examination of the various items of expenditure may help to bring it nearer once again. Salaries and wages have both been increased and are not likely to fall. Of capital costs the same may be said. The only outstanding point is whether a saving can, therefore, be made on the various items of the operating costs, and, if so, the problem remains as to how this is to be done. Unless it is done the rivers of electricity, in the hyperbole of the Lord Chancellor, are not likely to be more than small streams.

Are the Best Generating Methods Being Used?

Viewing the matter in the broadest possible light, electric power may now be generated in the following ways: By the use of water power, by oil fired into boilers, by the utilisation of peat, and by the employment of coal in some form or other. It is needless to add that by far the greater part of the electrical energy generated in this country is obtained by the last method. The employment of water power is not likely to come into the picture so far as super-stations are concerned. As far as we know, oil-fired boilers have not yet been used for generating electricity on land to any great extent, though, of course, they have been successfully employed in the Navy. Peat is in the same position as water power. Peat bogs do not exist near industrial areas, and a very large amount of that form of fuel must be used per horse-power generated. Coal in some form or other remains, therefore, the most efficient fuel.

Alternative Methods of Using Coal.

The next thing to consider is whether we are using coal in the best possible way, and, if not, whether our methods can be improved. This important question is gone into at great length in an appendix to the Report of the Nitrogen Products Committee. The possible methods of using coal at the present time are, apart from direct firing, high temperature carbonisation, according to either gas or coke oven practice, low temperature carbonisation carried on under reduced pressure or to allow the formation of benzol, complete gasification in recovery producers and combinations of the systems of low temperature carbonisation with subsequent gasification of the resulting coke in recovery producers. The details of these systems are unimportant at the moment except that it has been suggested that to use one or other of them in a generating station would be more economical than direct firing, owing to the fact that, not only electricity, but by-products would be produced with a definite market value.

Are By-Products an Advantage or Otherwise?

This question of by-products is an interesting one, but whatever may be said in its favour, there is no doubt it would introduce a most disturbing factor into the finances of any electricity undertaking. It is true that the sale of the by-products would help to set off the generating costs, and, though this at first sight seems an advantage, the extraordinarily large output of these commodities and the consequent fluctuations and fall in their market price might be distinctly harmful. Further, the enormous capital expenditure involved would go far to offset any advantages obtained. It is estimated that to establish a by-product recovery plant in conjunction with a super-power station of, say, 100,000 kw. capacity, would mean an increase in the capital costs of anything from 50 to 200 per cent., according to the system employed; and that while in a direct-fired station of this size the coal consumption would be from 650,000 tons annually, with a by-product recovery plant attached it would range from 860,000 to 1,620,000 tons, while something like 177,390 million cubic feet of gas would have to be handled. The scheme is, indeed, such a Brobdingnagian conception that imagination bogles at the very thought.

Apart from such considerations, however, other drawbacks to the idea of combining by-product recovery processes with a super-power station are the large acreage of land required and the general unwieldiness of the whole concern. For financial reasons alone the proposal to submit coal required for generating electric power to some sort of preliminary treatment is hardly worth serious thought, and a consideration of the proposal from the engineering and operating sides only serves to strengthen our view as to its impracticability.

Direct Firing the Most Economical.

The Committee compared the high temperature carbonisation processes under actual working conditions and found them more expensive than direct firing, while though the low temperature carbonisation processes seem to be slightly cheaper, the results are only theoretical, as these processes have not yet been used to any great extent on a commercial scale.

It should also be pointed out that the relative results given in the report are compared for different prices of coal, and it is found that direct firing shows greater economic advantages as the price of coal increases, so that as the comparisons were made at pre-war prices, direct firing is at the moment even more economical than the figures given in the report lead us to suppose.

It would, therefore, seem that we can use our coal resources most economically by continuing to employ direct-fired boilers. For ourselves we have never been very taken by the idea of imposing a by-product plant on an electricity generating station. This, we consider, is one of the cases where specialisation is best, though we are glad to have our views on this subject confirmed by the very painstaking work which has been carried out by the Nitrogen Products Committee. The problem re-stated, is therefore, how best can the coal at our disposal be used in the direct firing of boilers? This is a question for boiler designers and central station engineers, and it is one worthy of close consideration. The design and erection of the new super-power stations will mean the introduction of a series of new problems into the boiler house, and these must be tackled and solved without delay.

Joint Industrial Councils.

In the recent " Bulletin " of the Ministry of Labour there is an interesting review of the progress made by Joint Industrial Councils and an outline of the achievements of these bodies. It is stated that the outstanding feature of the past three months has been the establishment of three National Councils on which the Government as employer is represented. There is also progress to report in connection with the establishment of Industrial Councils for the War Office and the Ministry of Munitions. In addition, six other Joint Industrial Councils have been set up, making the present total 51. This evidence of the increase in co-operation with the improvement in methods and conditions of labour and the gain in wealth that will result from a wise extension of the Whitley principle is very welcome. Industrial questions of fundamental importance to the whole community are now before the nation, and the time is past when the solution of minor disputes and sectional difficulties is the whole function of industrial bodies. In this connection a noteworthy step is the attempt made by the Building Council to solve the difficulties of its own industry. At the root of all these matters lies the question of education, upon which attention is being directed. The question of statistics and research is another important field of activity.

There has been a considerable development in the establishment of District Councils, the number of which is growing rapidly. The National Councils will find their way cleared in many directions by the setting-up of local bodies; the speedier settlement of disputes, the detailed application of general agreements, the adaptation of industrial conditions to local needs, and general improvement in organisation are matters concerning which District Councils are the natural channels of progress. The Works Committee movement is also making progress.

Among the Joint Industrial Councils formed for industries in which electrical engineers are interested are the following:

Electrical contracting (formed Jan. 22, 1919), electricity supply (May 1, 1919), iron and steel wire manufacture (June 21, 1919), electrical cable making (Sept. 1, 1919), and tramways (Sept. 5, 1919).

District Councils.

The following District Councils have been set up or are in process of formation:

Electrical Contracting.—Areas: London, Southampton, Belfast, Birmingham, Leicester, Nottingham, Derby, Potteries, Newcastle, West Yorkshire, Bradford, Hull, Liverpool, Manchester, Sheffield, Glasgow, Aberdeen, Edinburgh, Dundee.

Electricity Supply.—Areas: North-East Coast, Yorkshire, Lancashire and Cheshire, South Wales, West Midlands, West of England, East Midlands, East Coast, Home Counties, Greater London, South Coast, Devonshire and Cornwall, Scotland.

Tramways.—Areas: Scotland, Northern, Lancashire, Cheshire and North Wales, Yorkshire, Lincolnshire, North Derbyshire, South Wales, Midlands, Metropolitan, South-West, East, South-East.

Works Committees.

The Joint Industrial Council has approved of the principle of Works Committees for (among other industries) the tramways and wire manufacturing industries.

Ex-British Westinghouse Association Annual Re-Union Dinner.

Mr. W. W. Hughes presided over a gathering of 160 ex-British Westinghouse engineers at the Holborn Restaurant, London, on Friday evening last. The association has for its object the promotion of friendly relations between men who originally met under the British Westinghouse banner at Trafford Park.

The proceedings commenced with a re-union in the reception room. Judging by the buzz of conversation, this opportunity for a friendly chat was taken the fullest advantage of, and the guests sat down to dinner in a pleasant frame of mind.

After the loyal toasts had been honoured, Mr. P. A. Sanders, O.B.E., proposed the " Ex-B.W. Association." He asked all ex-B.W. men to join, because it was not a business association, but a medium through which old and new friends could be met. Mr. L. R. Morshead responded on behalf of the Committee, and remarked on the successful formation of the association and its increasing popularity. The Chairman then gave the toast of the guests, to which the only guest present, Lieut.-Col. Montague Craddock, C.B., C.M.G., an old and popular British Westinghouse director, replied. He expressed his pleasure at being present, and made touching reference to his friendship with the late Mr. George Westinghouse. In particular he referred to his high spirits and the ability he possessed of imbuing other engineers with them. During the speeches fitting testimony was given to Mr. L. S. Richardson, the hon. secretary, for the work he had done in promoting the association and organising the gathering again this year. The members were especially pleased with Mr. Richardson's programme and toast list. It is a highly humorous production, and contains many telling skits on various members of the association. We may mention with approbation such items as " The Ex-B.W. Association " (proposed by Mr. Sanders, O.B.E.), " The Hurry-Up Bell will be rung at the end of 5·3 minutes, and a fire extinguisher will be brought into play after 7·28 minutes; if it is used, the O.B.E. will be O.P.H." Also the toast of " Our Guests " was followed by the injunction: " Estimated time for delivery 10 minutes after termination of moulders' strike."

The concert programme was contributed entirely by members of the association. Mr. A. Simon accompanied, Mr. Pochobradsky played the violin, Mr. H. S. Aspinall and Mr. F. Ollerenshaw contributed songs, and the humorous items were furnished by Mr. Val Wood and Mr. E. H. Miller. Mr. Richardson again introduced the Bombass, which was uproariously received.

In short, a thoroughly enjoyable evening was spent, and practically all the members promised to turn up next year. We would remind our readers that membership of the association is open to men who were employed on the staff of the British Westinghouse Company for two years, and who completed two years' service prior to September 30, 1919, that the annual subscription is 2s. 6d., and that the hon. secretary, Mr. L. S. Richardson, 11, Sydney-road, Richmond, Surrey, will be only too pleased to furnish full particulars to all ex-B.W. men who would like to join the association.

Bread Delivery by Electric Vehicles.

Already some hundreds of bakery concerns in the United States and elsewhere have selected, after exacting tests, the electric commercial vehicle as that mode of transportation best suited to their business, for, in addition to being the most efficient, economic and dependable type of transportation, the electric truck is the cleanest, and, on account of its simplicity, the easiest to operate. The chief advantages of the petrol car are speed and unlimited mileage; but the electric vehicle is ideal where frequent stop deliveries are necessary, and where the range of operations are within the capacity of a storage battery—that is to say, up to 40, 50 or more miles per day, which has proven to be more than ample for urban operations. It has been estimated that approximately 85 per cent. of all urban transportation can be successfully dispatched by electric transportation, and from this standpoint the field of the electric vehicle is well-nigh limitless.

Not only is the electric vehicle the favourite mode of transportation by bakeries on account of its cleanliness, but also because of its dependability, ease of operation and relatively low operating costs. Dozens of letters have been received from representative baking concerns, who have unqualifyingly endorsed electric transportation. The following is a list of the larger users of electric vehicles, with the approximate number of vehicles employed:—

Ward Baking Company (operating in eight cities), 460; Ward & Ward (Buffalo), 129; Ward-Corby Company (Chicago), 70; Case & Martin Pie Company (Chicago), 65; Consumers' Bakery Company (Kansas City), 65; Cushman Sons Company (New York), 56; Mills-Fox Baking Company (Detroit), 55; Ward Brothers Company (Rochester), 50; Campbell Baking Company (Kansas City), 40; Loose-Wiles Biscuit Company (New York), 35; Shultz Bread Company (Brooklyn), 35; Old Homestead Bakery (San Francisco), 30; Flour State Baking Company, (St. Paul), 26; Schulz Baking Company (Chicago), 25; General Baking Company (New York), 25; and Horn & Hardart Baking Company (Philadelphia), 20. In addition, about a dozen other firms use 10 or more electrics each, and the whole employ approximately 1,200 electric delivery wagons. These fleets represent unmistakable evidence of the superior advantages of electric transportation in the baking industry. Similar conditions are to be found in a number of other industries, where many of the largest transportation fleets are composed chiefly of electrics.

One of the most recent series of electric vehicle installations by a bakery company is that of the Cushmans' Sons (Inc.), which operates plants and stores in Greater New York. The company purchased in March, 1919, 14 1-ton vehicles; in April, two 6-ton; in May, 30 1,000 lb.; and in December 10 1,000 lb. electric trucks, or a total of 56 electric vehicles during the year. It is expected that this fleet will be augmented considerably during 1920.

The Ideal Home Exhibition at Olympia.

We are glad to learn that when the above exhibition opens on February 1 there will be a good display of electrical apparatus by various manufacturing firms. The General Electric Company, Ltd., are erecting a complete house on their stand, and will be showing therein a selection of up-to-date lighting fittings and apparatus such as are required for the Ideal All-Electric Home. There will be an electric cooker in the kitchen, together with an electric hot-water heater and incidental labour saving appliances in the form of dish washers, clothes washer, vacuum cleaner and domestic table cooking accessories. Naturally heating will be done by " Magnet Fires."

Messrs. Strode & Company propose exhibiting an oil engine driven lighting plant set together with a representative display of electric bells, telephones, heating and cooking apparatus, &c.

The " Magicoal " Fire and " Colec " heating system will be found on the stand taken by Berry's Electric, Ltd., and heaters and cooking apparatus generally are being exhibited by Belling & Company and L. G. Hawkins & Company.

To demonstrate the ease with which the " Kalecco " wiring system can be used to match in with varying styles of decoration, Messrs. Callenders are arranging their stand to represent on one half a portion of a working class living room and on the other half a portion of a middle-class dining room. Doubtless when the exhibition opens other interesting exhibits will come to light, and a description of the exhibition will be given in these columns. The exhibition will remain open for three weeks.

Restoration of Pre-War Practices.

Last week the Derby Munitions Tribunal (Alderman W. B. Robotham presiding), the umpires being Mr. T. Whiston for employers and Mr. W. H. Mills for workmen, heard a complaint by Mr. Arthur Shaw, an official of the Amalgamated Society of Engineers, that Messrs. Newton Brothers, electrical engineers, of Derby, had failed to comply with the restoration of Pre-War Practices Act, 1919, by continuing to employ women and girls on armature winding, which was previously done by skilled men and apprentices. Mr. Shaw, who referred to the agreement between the Treasury and the Trade Unions, said only a few firms throughout the country (not more than half a dozen) had failed to honour the agreement.

Mr. J. De Looze, chairman of the Derby District Engineering Trades Employers' Federation, conducted respondents' case.

Mr. F. V. Pipe, works' manager for respondents, described the various processes of armature winding, and said the work was done by women everywhere. His firm employed men on a bigger class of armature before the war, but that particular sized armature, which was used in connection with aeroplane manufacture, was only undertaken by them whilst the war was in progress. It was of such a "finnicky" character that he was confident men could not be found with patience to do it as a repetition job.

Other witnesses included Mr. R. G. Hosking, assistant works' manager of the British Thomson-Houston Company; Mr. C. W. Blackburn, works' superintendent for C. A. Vandervell & Company; Mr. B. G. Pickering, works' superintendent for the General Electric Company; Mr. E. Greenhalgh, chief engineer of Electro-Motors, Ltd., and Mr. C. P. Bramley, works' manager of the Lancashire Dynamo and Motor Company. These witnesses testified that it was the custom of the trade for women and girls to wind armatures of the size and description of those referred to in the case.

The Court unanimously dismissed the complaint, holding that Messrs. Newton Brothers were within their rights in employing women on the work, which, as it was not done by them before the war, involved no departure from pre-war practice.

The "A.W.P." Welding Process.

The progress made in electric welding during the past few years is one of the outstanding features of recent engineering developments. Electric arc welding has, of course, been in use for some time, but until quite recently it was mainly confined to repair work which could not be undertaken by any other means and to the assembly of minor parts. It has now been found that the electric method can be employed satisfactorily in all operations where the gas blow-pipe used formerly to be adopted, and that it further possesses the great advantages that it can be set to work at short notice and that the weld obtained at any rate in skilled hands is superior to that obtained when other methods are employed. As we have announced in these columns an electrically welded ship has recently been launched. This in itself indicates considerable advance, while great progress also has been made in the development of suitable plant and equipment to provide the desired electrical conditions at the arc so necessary for a good weld.

To obtain and stabilise these conditions a large amount of detailed research and experiments have had to be carried out and the usual failures faced and overcome. At first carbon or bare metal electrodes were almost exclusively employed, but recently the advantages obtained by the use of a flux-covered electrode has been realised, and one of the most successful efforts that have been made in this direction are those of the Alloy Welding Processes, Ltd., who have made an exhaustive study of the subject, devoting special care to the question of electrodes. It may be recalled that the standard type of A.W.P. electrode is provided with a coating formed of variable constituents. There are, in fact, we understand, no less than 14 different types of flux covering of electrode in use, the particular one employed depending on the character of the metal which it is desired to deposit. By using this method it is claimed greater speed in obtaining the welds is permissible, while less skill is necessary on the part of the man manipulating the apparatus.

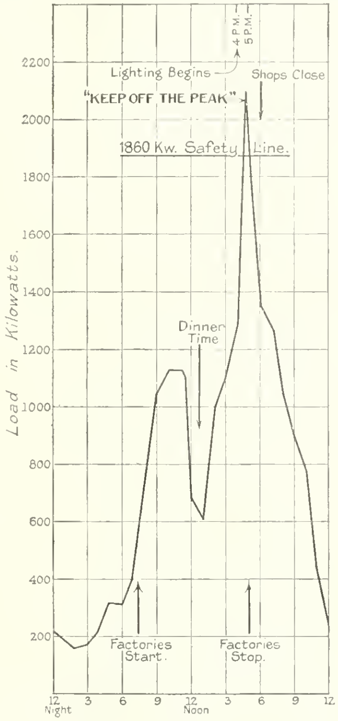
We recently had an opportunity of inspecting a number of welds which have been carried out by this process and saw steel plates, angles, channels and expanded metal which had been welded in this way and had subsequently been submitted to the tests laid down by Lloyds for this class of work. The results seemed most satisfactory. It should be noted that in this process the metals comprising the alloys that have been deposited are kept apart until they have been actually fused in the arc, as it is claimed that this is the only possible manner whereby high-speed nickel manganese and other special alloys can be deposited.

An interesting application of the A.W.P. process is seen in the manufacture of machine tools. A mild steel shank is used, one end of which is slotted. The shank is then fixed in a vice with the slot uppermost, and into it is welded a filling of high-speed steel from a special electrode. This filling is then ground up in the ordinary way to a cutting edge and forms, it is claimed, as efficient a cutting tool as if the whole were made of special steel. By this method there is, therefore, no loss in efficiency, while at the same time there is a great gain in cheapness. When the cutting edge is worn down it can, of course, be renewed by a further process of re-slotting and re-filling.

We shall hope to refer to some further details of this process in a subsequent issue.

The Peak Load.

The majority of electric supply engineers have from time to time experienced difficulties in connection with the maintenance of the supply of electric current during the period of the peak load. These difficulties have been accentuated since the Armistice owing to the shortage of plant, the necessity for carrying out long overdue repairs, &c. In many places restrictions have had to be imposed upon the consumption of electricity; some consumers have had to be cut off temporarily and others have been asked to exercise economy in the use of energy during the time of the greatest demand upon the generating station. Like others, the Grimsby electricity department has had to appeal to its consumers to exercise economy, and this appeal was made in a most striking and effective manner. The plant at the station could deal with a load of 1,860 kw. with safety, but between 4 and 5 p.m. there was a peak load of about 2,100 kw. Consequently the borough electrical engineer (Lieut.-Col. W. A. Vignoles) prepared and issued a poster, with a diagram showing the output of energy from the electricity works during an ordinary week day, and this was accompanied by an appeal "to keep off the Peak." We reproduce the diagram, as it seems to us to be a neat and very effective way of showing the exact position of affairs to electric supply consumers.



Load Curve, Friday, Nov. 14, 1919.

The Liverpool Lock-out.

The lock out of electricians in the Liverpool district continues, and the local secretary of the National Federated Electrical Association has issued a statement on the matter. The dispute originated with the consideration of a new code of working rules providing for a 47-hour week, 2s. per hour for a competent electrician, armature winder or cable-jointer; overtime at time and a half for the first four hours on the first five days of the week, &c., and in all there were 17 amendments to the existing rules. The men say that the rules have been agreed with the local employers. The constitution of the National Joint Industrial Council does not give them authority to ratify, but the Council had the right to veto any particular rule. As the National Council had merely put forth amendments, which were rejected by the men's representatives, and had not vetoed the rules, the men claimed they should be in operation, and in some shops they came out on strike. The employers on the other hand, through the Federated Electrical Association state, that the rules were agreed with the men and were sent as a recommendation to the Joint Industrial Council for ratification, but they were referred back to the District Industrial

Council for further consideration. The Union members then stated they were not prepared to accept any amendments and resigned en bloc from the District Council, and the Union demanded the adoption of the rules, failing which all overtime would be stopped. The District Council requested that action be deferred until after the meeting of the Council of the National Federated Electrical Association in London on the 21st inst., but through the E.T.U. not complying, the local employers were compelled to declare a lock-out, not only in support of the four firms who were being victimised but as a means of hastening a decision. A deputation from Liverpool put the case before the N.F.E.A. on the 21st inst., with the result that the Council decided to approach the Executive of the E.T.U. asking them to agree to submit the case to an arbitrator appointed by the Ministry of Labour, the Council being of opinion that the question involved other districts, and was therefore a national question of great importance to the industry.

Ringing Vibrator.

We illustrate herewith a ringing vibrator which has recently been put on the market by Messrs. Siemens Brothers & Company. This instrument is intended to supply ringing currents for small or medium telephone exchanges. It consists of a device for converting a battery current to a current suitable for ringing magneto telephone bells, and thus enables the operator to call stations by merely pressing a key instead of having to turn the handle of a generator. The apparatus which consists of a specially designed vibrator and system is employed in conjunction with a high efficiency transformer. Both these instruments are contained in one case. The vibrator is provided with a substantial tungsten break, which it is claimed will allow efficient operation for long periods without attention. Terminals are arranged on the outside of the case so that the necessary connections may be made without opening the instrument. We are informed that the instruments will ring 30/1,000 ohm magneto bells when connected in parallel. It may be used either in conjunction with a six volt or 22 volt battery.

Legal Intelligence.

Electric Lamp Patents.

On the 20th inst. Mr. Justice Sargant commenced the hearing of an action by the British Thomson Houston Company, Ltd., against the Corona Lamp Works, Ltd., for an injunction restraining defendants from infringing plaintiff's letters patent No. 10,918 relating to improvements in incandescent electric lamps and to gas filled lamps in contradistinction to vacuum lamps. Plaintiffs also asked for damages, an account of profits and delivery up of infringing articles. Defendants denied infringement.

Mr. Colefax, K.C., Mr. J. Hunter Gray, K.C., and Mr. Whitehead appeared for plaintiffs; and Mr. Kerly, K.C., Mr. R. Frost and Mr. J. Ewart Walker for the defendants.

Mr. Colefax said the inventions in the case had given rise to what was called in the trade and by the public the "½-watt lamp." After a history of incandescent electric lamps and their improvement, he said that the invention in question was worked out in the laboratories of the General Electric Company in the U.S.A. The result was that much higher efficiency was obtained by the use of gas filled lamps in conjunction with a thick filament, that filament not necessarily being tungsten. It was found that by filling the lamp with an inert gas having no conductivity but with a relatively light pressure and using either a thick or a spiral filament a lamp could be produced of a higher efficiency than any that had previously been put on the market. Defendants, who relied on various specifications of other patents, which they said disclosed the invention, also alleged that there was invalidity and insufficiency, and denied infringement. They admitted selling lamps which plaintiffs said infringed the patent, being gas filled and having special filaments.

Mr. J. Swinburne, F.R.S., said it was found that the tungsten lamp could not be run commercially under one watt per candle, and the inventor realised that if he put a suitable gas into the bulb it might stop the vaporisation of the filament and carry away the heat. He also found that under the proper conditions with a thick filament the light was increased. The result of the invention was a fundamental change in the process of lamp manufacture, which was of enormous commercial importance. It was, in fact, one of the biggest steps in lamp manufacture that he knew.

In cross-examination Mr. Kerly asked witness to suppose that he wanted to convert an existing vacuum lamp into a gas filled lamp, the former having a filament of definite length and thickness, and if he wished to get the same candle power with the same voltage, there were four possible combinations which counsel put to witness: he could increase the section and retain the length of the filament; reduce the length and retain the section, or reduce the section and retain the length. If these three possible combinations were excluded there was a fourth, viz., to reduce the section and also the length; and Mr. Swinburne agreed that that was the only way he could turn a vacuum lamp into a gas filled one for the same candle power and fixed voltage.

Dr. Passmore, consulting chemist, said he had considered plaintiffs' specification and the various alleged anticipations. He saw no difficulty in comprehending the invention or in putting it into practical use. In plaintiffs' specification were the words "in concentrated form," and he saw no difficulty in applying that alternative practically. The object of the concentration seemed to be self-evident. One was working in a gas. One knew with the exposure of the surface that the surface cooled the mass considerably. One wanted to expose less surface, and one concentrated the mass, still retaining the filament, of course. Contrasting the filament in a lamp in accordance with the invention and the tungsten vacuum lamp range of temperature was from 2,000° at which the vacuum tungsten lamp ran, to 2,500° up to 3,000° at which they could and must run in order to get the increased efficiency. The specification referred to tungsten or other refractory metal. At the date of the patent there were other refractory metals than tungsten known—tantalum, osmium and molybdenum. So far as the specification was concerned, there was nothing at all helpful in obtaining any advance upon the tungsten lamp as it existed at the date of the patent.

Mr. Edward A. Gimingham, M.I.E.E., also gave evidence for the plaintiffs, and in cross-examination he said the specification was an advance on all previous practice.

In re-examination, Witness said that the approximate efficiency of tungsten over carbon filaments was 3 to 1¼. In each form of incandescent electric lamp the difficulty had been to get a low candle-power with a high voltage. So far as gas filled lamps were concerned, improvement was still going on.

Mr. J. H. Gray, K.C. (for plaintiffs) said sales of the patented lamps in this country could be proved to amount to 5,800,000. Addressing the Court on the conclusion of plaintiffs' case, Mr. Gray said none of the prior documents relied on in the case showed a combination of gas and coiled wire. As to the suggestion that there was a wonderful combination or ring that controlled the tungsten filament, all he could say was that that had not been proved. There was a large number of patents for tungsten filament lamps, but not one of them approached the combination now invented.

Mr. Kerly opened defendants' case, but the action had not concluded when we went to press.

Cinema Supply Charges.

A point involving the rate to be charged for electricity supplied to cinemas came before a Divisional Court on Friday on an appeal from the County Court Judge at Paignton. The Paignton Electric Light & Power Company appealed against a decision in favour of plaintiff in an action by Mr. Wm. Landsdell, proprietor of a cinema hall at Paignton, for the recovery of alleged over-charges, his case being that he had been charged for electricity at the rate for lighting instead of the lower rate for power.

Mr. Hutchings, for appellants, contended that the decision was against the weight of evidence. The judge had held that Mr. Landsdell should be charged at the rate for power, and not for lighting. If the decision was right, it meant that anybody could obtain electric current and use it for lighting purposes, and yet only pay the power rate for it. The company's rate for lighting was 7d. per unit and for power 3d. The electric current supplied to the cinema hall passed through a transformer, receiving the current at a voltage of 440 and reducing it to a voltage of 60. The object of the reduction in voltage was to avoid spluttering. After being transformed to the lower voltage, the power was used in an arc lamp that lit the bioscope and threw the figures on to the screen. The company's contention was that the current was supplied for lighting, and that they were entitled to payment at the higher rate. There was a separate meter for the current for power, and the greater part of the energy supplied was undoubtedly used for lighting. The County Court Judge had found that he must look at the primary use of the energy, and not at the ultimate result, in order to decide to what objects the energy was applied. Unquestionably, the ultimate result was the illumination of the arc lamp.

Mr. Justice BAILHACHE: I see it is suggested that the company does not supply the current for lighting, because it is passed through a rotary converter. If the electricity passing through 34 amperes go to lighting and 1 ampere to power, the company charge lighting price for the whole.

Mr. HUTCHINGS: I submit that only to the extent of one-thirty-fifth would we be wrong in charging lighting price for the whole.

Mr. JOWETT, for respondent, said it was really a question of how the electricity which lit the arc lamp came into existence. Respondents' case was that "the electricity supplied by the company caused a wheel to rotate a dynamo." It was a mere accident that the dynamo was driven by electricity supplied by the company instead of by oil or gas. In case the electricity supply failed there was an auxiliary gas engine to work the dynamo. The dynamo generated a new type of electricity, and therefore the current supplied was used for power.

Mr. Justice BRAY: Then if I, as a householder, want a supply of electricity for lighting at power rates, all I have to do is to get a transformer.

Mr. JOWETT: Yes. Whether it would be a good business proposition would depend upon the size of your lordship's house. I believe that in a large number of hospitals and other institutions they have their own transformer in order to get power rate.

The hearing was adjourned for a report of Mr. Swinton, the electrical engineer, who gave evidence before the County Court Judge.

The Glasgow Tramway Lottery.

We regret to notice that the Government (through the Lord Advocate) is suing Mr. James Dalrymple, manager of Glasgow Corporation Tramways, for the recovery of a penalty of £200 under an Act passed in 1823 (the 3 George IV., Cap. 60). In May, 1919, the members of the City Business Club, Glasgow, arranged to raise money for the entertainment of limbless sailors and soldiers by means of a lottery, the prize being a £50 War Savings Certificate. It is alleged that defendant, who took a leading part in connection with similar schemes, was well aware that the proposed lottery was illegal. The criminal authorities had taken objection to earlier schemes, and in September, 1918, there was communicated to defendant a letter (from the Procurator-Fiscal to the Town Clerk) intimating that as the law stood any future issue could not be made without incurring risk of prosecution. Notwithstanding this defeadant is alleged to have arranged with the City Business Club that 50,000 tickets should be placed in his hands for sale to the public. It was agreed to sell them through the tramway employees, who were to have 2s. 6d. remuneration for selling each 100 tickets, but as £565 10s. 6d. was paid to the club, some of the employees did not deduct their commission. Each sale of a ticket was a contravention of the statute, and in respect of each offence defendant was liable to forfeit £50, but the claim is restricted to four sales made to detectives.

The defendant denies the allegations, and states that in June, 1917, the sale of tickets for prize drawings was discontinued; that during 1918, at various places in the United Kingdom, schemes for encouraging the sale of War Savings Certificates and War Securities were devised, in which prize drawings were an important feature, and such schemes were carried on without remonstrance by the criminal authorities. In May, 1919, representatives of the Club informed defendant that they had collected money for a prize, and had arranged to sell tickets, and asked him to assist them. He agreed to allow employees to sell tickets voluntarily, and he agreed to collect and forward to the Club the money received. He did not withdraw the general instruction prohibiting the sale of tickets on the cars, and he denies contravention of the statute. In any event he avers that the statute is antiquated, and is now in desuetude.

The record was closed, and the case sent for trial.

Breach of Factory Regulations.

At the Glasgow Sheriff Court last week Messrs. Grindlay, Ross & Company, Ltd., electrical engineers, were charged at the instance of Mr. W. D. Kirkwood, H.M. Inspector of Factories, with having failed to efficiently protect electric wires for the conveyance of electricity for lighting purposes in the Lambhill Iron Works, in consequence of which John M'Kay, 16 years of age, was killed on Aug. 13 last. A temporary installation had been carried out to give light to two punching machines. Owing to the presence of a crane overhead lighting was not feasible, and respondents' electrician placed the cable on the ground between the machines. The voltage was about 240 alternating current, and on Aug. 13 M'Kay, while walking to one of the machines, stepped on to some iron plates on top of the electric wire and received a shock, from which he died. Respondents' representative stated that after the accident occurred he disapproved of the way the job had been done. The wire should have been overhead or laid in underground conduits.

On behalf of respondents, it was contended that the firm, having employed a journeyman electrician on the work, the fault did not lie with them. Their employee had no authority to break the regulations.

Sheriff Lyell said that the mere fact that respondents chose to perform their contract through a workman would not relieve them of responsibility. The fault was entirely with their employee, who had betrayed an utter recklessness of the lives of fellow-workmen. Respondents had committed a technical offence and he imposed a fine of £15, with £5 costs.

Commercial Topics.

Association to Fight Government Control.

We are pleased to see that a group of private trades have formed the "Amalgamated Trades' Association" for the purpose of fighting Government trading, nationalisation, and bureaucratic control of industry. The head office of the association is at the London Chamber of Commerce, Cannon-street, E.C., and the secretary is Mr. B. G. Arthur. Among the members of the Executive are Mr. C. F. Partington, J.P., Mr. F. W. Parsons, and Mr. Arthur J. Mills. The objects of the new movement are to defend private enterprise and to convince the country that the Government in the National interests should leave trade to the traders. The promoters believe that the principle of competition, based on personal energy and initiative, has been a prime factor in building up the commercial greatness of the country, and that to abandon that principle would be to condemn British trade to stagnation and decay.

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British Non-Ferrous Metal Association.

This association was registered on the 21st inst. as a company limited by guarantee, but not formed for profit. The word "limited" has been omitted from the title by licence of the Board of Trade, and among its objects are the promotion of research and scientific work in connection with the study, production, treatment and utilisation of non-ferrous metals and alloys, &c. The number of members is unlimited, and each member is liable for not more than £5 in the event of a winding up. There is a council of 19 members, and among these members are Messrs. T. Bolton (T. Bolton & Sons), C. Cookson, S. Evered, A. P. M. Fleming (Metropolitan-Vickers Electrical Company), H. E. Howard, G. H. Muntz, W. M. Morrison (British Aluminium Company), F. Tomlinson (Broughton Copper Company) and A. H. Wiggin (H. Wiggin & Company).

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Property Belonging to German Subjects.

The Board of Trade again drew attention to the Order in Council under the Peace Treaty with Germany, under which all the property, rights and interests which are situate anywhere within the British Empire belonging to German nationals at the date when the Treaty came into force, irrespective of where the owner or owners may be resident, are charged for the purpose of securing the claims made by British nationals with regard to their property in Germany and debts owing to them by German nationals. The charge does not extend to property which may have been acquired under the Board of Trade General Licence of July 12, 1919, authorising the resumption of trade with Germany.

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Electrical Development Associations.

The Electrical Development Association, which has already done much useful work in connection with the applications of electricity to industrial, commercial and domestic uses, was registered on the 17th inst. as a company, limited by guarantee, but not formed for profit, the word "limited" being omitted from title by licence of the Board of Trade. The title has also been altered to the BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION, as it was found that another body had been registered with a title somewhat similar.

Among the objects of the newly incorporated Association are the promotion and the protection of electrical industry and enterprise in the British Empire, the development of the use of and demand for electrical energy for industrial, commercial, public, domestic, agricultural and other purposes, &c. There are to be founders, ordinary members and associates. It will be seen that the first members of the Committee are representative of the supply, manufacturing and contracting branches of the electrical industry, and are as follows: S. T. Allen, L. B. Atkinson, C. O. Bastian, C. R. Belling, A. F. Berry, J. H. Bowden, W. A. Chamen, John Christie, A. C. Cramb, R. S. Downe, D. N. Dunlop, J. E. Edgecombe, J. W. Elliott, S. E. Fedden, W. A. Gillott, E. E. Hoadley, E. T. Ruthven Murray, H. C. Palmer, A. R. Phipps, F. J. Walker, D. Watson, F. H. Williams, W. B. Woodhouse and C. H. Wordingham.

There is an Executive Committee of 11 members, of which Mr. A. F. Berry is chairman and Mr. D. N. Dunlop vice-chairman, with Mr. J. W. Beauchamp as director and secretary. The Association will continue to carry out, on a co-operative basis, its publicity and propaganda work on behalf of the electrical industry. Funds for the preliminary work have been provided by the Institution and associations represented on the committee of management, and subscriptions are now invited from public bodies interested in electricity supply, from manufacturers of electrical plant and apparatus, electrical contractors, &c.

Each founder (including the Institution of Electrical Engineers, the British Electrical and Allied Manufacturers' Association, the Incorporated Municipal Electrical Association, the Incorporated Association of Electric Power Companies, the Electrical Contractors' Association and the Electric Lamp Manufacturers' Association of Great Britain) is to be entitled to one representative of the Council.

Another interesting registration is that of the LONDON ELECTRICITY JOINT COMMITTEE (1920), LTD., which took place on the 21st inst., with a capital of £50,000 in £1 shares. Its objects are to prepare schemes with a view to the improvements of the organisation of the supply of electricity within the Counties of London and Middlesex and the adjoining counties and districts. The subscribers (each with one share) are: W. F. Fladgate, chairman Charing Cross, West End and City Electricity Supply Company, and Lord Downham, chairman Westminster Electric Supply Corporation, The Board shall consist of one authorised representative of each of the companies and local authorities who are for the time being members of this company. Until such directors are appointed the subscribers are deemed to be the directors.

Electricity Supply.

Burton-on-Trent Corporation has increased the salary of the chief electrical engineer (Mr. T. Hall) to £650 per annum.

Hackney (London) Borough Council are recommended to carry out extensions of the electricity undertaking at an estimated cost of £134,000.

For extensions of mains, services and transformers Harrogate Corporation has applied for sanction to borrow £6,500.

Hastings Corporation has applied for sanction to a loan of £3,000 for new meters.

The Gravesend Corporation is recommended to put down a new 3,000kw. turbo-alternator, two boilers, &c., and the Town Clerk has been instructed to communicate with the Ministry of Transport on the matter.

Greenock Electricity Committee recommends the Corporation to apply for sanction to borrow £170,000 for additional plant and for mains extensions.

Owing to the proposed increased charges for electric current Ammanford Urban Council has decided to negotiate with Mr. Wm. Herbert for the purchase of the electricity undertaking.

Extensions to the electricity works are to be carried out by Poplar Borough Council at a cost of £68,000, in order to give a further supply of electrical energy to the Port of London Authority.

In our description of the Manchester-Salford linking-up scheme which appeared on page 81 of last week's Electrician, we omitted to state that the three-phase transformers at the Manchester end were made by Messrs. Ferranti Limited.

Tunbridge Wells Corporation has received sanction to borrow £19,279 for extensions of the electricity undertaking, but a decision upon the remainder of the Council's application has been deferred until tenders for plant have been received.

Coventry Corporation proposes to erect a new power station, which, it is estimated, will take four years to complete. The City Electrical Engineer (Mr. G. Tough) is to be entrusted with the supervision of the work, and he is to be paid £1,600 for his special services.

Unless additional boiler and other plant is installed Llandudno Urban Council cannot guarantee an adequate supply of electric current for lighting, power and traction for next summer. The Board of Trade recently informed the Council that it would be some time before a district electricity board would be set up in North Wales under the Electricity (Supply) Act, and it has therefore been decided to adopt the suggestion to continue the negotiations with the North Wales Power and Traction Company for a bulk supply.

An inquiry was held at Stafford on the 21st inst. into the application of the Council for sanction to borrow £65,000 for additional plant at the electricity works. The original application was for £30,000, but £65,000 would be necessary as consumers had applied for additional large supplies of electrical energy. Mr. Robins, borough Electrical Engineer, said they required two 1,250 kw. turbo-generators, a 1,000 kw. rotary convertor, two Stirling boilers, each of 15,000 lb. evaporative capacity, economizers, steel shaft and induced draught plant, &c. Nine local firms would require 2,000 h.p. within the next twelve months.

A special meeting of Cannock Urban Council was held last week in order to consider the question of electricity supply. Letters were read from the Board of Trade and the Council's Parliamentary agents, indicating that Walsall Corporations proposed to extend their mains from Bloxwich to the Mid-Cannock Collieries. At the urgent request of the Colliery Company the Board of Trade would not agree to the Council cutting up a generating station, the policy being to distribute current from a big central station. One member thought that Walsall Corporation should be asked to supply current in bulk as Cannock Council had the power to supply. A sub-committee consisting of the chairman and seven other members were elected to discuss the matter with Walsall Corporation.

It has been decided to set up a District Industrial Council for the electricity supply industry in South Wales and Monmouthshire, and a drafting committee has been engaged on a constitution. All of the municipal and company-owned electricity undertakings and the trade unions in the area were represented at a meeting at Cardiff last week when the draft constitution was unanimously adopted. The council will be known as "District Council (No. 4) South Wales and Monmouthshire Area Electricity Supply Industry," and will consist of 24 members, equally divided between representatives of the employers and of the Trade Unions. The first meeting of the Council will be held at Cardiff on Feb. 12.

The Examiners of Private Bills have found that the following Bills have complied with the Standing Orders of the House of Commons:— Nantyglo & Blaina and Brynmawr Electricity Board. Tyneside Tramways & Tramroads Company. Sheffield Corporation, Derwent Valley, Calver & Bakewell Railway. Underground Railways and the North Metropolitan Electric Power Supply.

The promoters of the Dartmoor Hydro-Electric Bill decided to restrict their powers to erecting overhead mains for supplying such surplus power beyond the requirements of their proposed copper refining industry in mid-Devon, which they produce from lignite beds they intend to develop, and as the portion relating to the use of the Dartmoor streams has been abandoned the Bill was allowed to proceed.

There was no appearance on behalf of the Bill by Stoke-on-Trent Corporation (for powers to purchase undertakings of North Staffordshire Tramways and the Potteries Electric Traction Companies) or the Thames, Ocean, Wharf & Railways Bill.

Electric Traction.

Coventry Tramways Committee has applied to the Ministry of Transport for sanction to loans amounting to £126,081 in connection with the reconstruction of tramways.

Llantrisant and Llantwit Vardre Rural Council are applying to the Light Railway Commissioners for an order authorising them to maintain and work a light railway from Gilfach Goch to Penrhiwfer, terminating at the latter place in a junction with the tramways leased to the Rhondda Tramways Company.

The accounts of the Yorkshire (West Riding) Electric Tramways Company for 1919 show, after providing for debenture interest, a net income of £42,671, which, added to £2,526 brought forward, makes £45,197. Dividend of 6 per cent. per annum on the preference shares absorbs £9,715; purchase of funded preferential dividend certificates, £12,837; renewals, depreciation, reserve fund, in lieu of accident insurance and general reserve fund, £21,259; leaving to be carried forward £1,386.

The assessment of the Glasgow Corporation tramways undertaking for 1920-21 has been reduced from £298,165 to £263,258 for 1919-20, but the Tramways Committee is appealing against the valuation, and the income-tax assessment (£77,920) is also being appealed against.

An approximate sum of £2,100 has been realised from the sale of lost property, money found on cars, and conductors' "overs" during the past year. Of this amount £500 is to be allocated to the departmental friendly society and the balance to the superannuation fund.

The accounts of the Newcastle-on-Tyne Corporation tramways for the year ended March 31, 1919, show revenue £472,694 (compared with £427,286 in previous year), of which £11,122 (£9,257) was paid to the Tyneside Company for through running, gross profit £165,604 (£178,892), and, after providing for interest, rents of leased lines, &c., income tax, loan and sinking fund contributions insurance reserve, contributions in relief of rates (£15,385, compared with £15,428) and allowances to employees on military service (£13,178, compared with £16,831), the net surplus was £45,000 (£55,000). Traffic revenue per car mile was 18·94d. (16·82d.) and total operating costs were 12·56d. (9·98d.). Passengers carried were 101,631,660 (91,648,545) and car miles run 5,856,829 (5,971,329).

An inquiry was held last week by the Light Railway Commissioners into the application of the Dearne Valley Board (the Urban District Councils of Wombwell, Bolton-on-Dearne, Thurnscoe and Wath) for an Order authorising an increase of their borrowing powers under their already sanctioned scheme, to increase fares and freights, and to abandon an authorised route from Bolton-on-Dearne, via Manvers Main, to Wath, and to submit a previously rejected route from Wath to Bolton, via the railway stations. The Great Central, Midland and the Hull & Barnsley railway companies and others opposed the application. Evidence was given by Mr. A. R. Hoare (Messrs. Stephen Sellon & Partners), who said it was proposed to increase the borrowing powers from £159,688 to £299,898. It was also proposed to increase ordinary and workmen's fares and parcel rates by 1d. in each class, and to shorten the route from 18 miles to 15 miles, with a corresponding reduction in rolling stock. The direct route between Wath and Bolton was vital to the scheme; otherwise the scheme would be split and become two undertakings. At the conclusion of the enquiry the Commissioners reserved their decision.

Imperial and Foreign Notes.

The additional tax of 55 centimes per franc, which has latterly been levied on the cost of all foreign telegrams by the French Post and Telegraph Department was provisionally removed on the 22nd inst. A plan is under consideration to safeguard the interests of the Treasury where part of the telegraph charges have to be refunded to foreign companies in foreign currency with a consequent loss on exchange.

It is announced that the Italian Government, having found the Wireless Service between Carnarvon and Rome more efficient than others, has instructed its delegation in Paris to adopt the Carnarvon-Rome route for all its important messages. It is understood that these messages are cabled from Paris to London and there handed over to the Marconi people for transmission to Rome.

The Federation of British Industries has accepted the invitation of important members of the West Indian Commercial Community to send a representative to the special Conference of the Associated Chambers of Commerce of the British West Indies on the 23rd prox., and Mr. Moir Mackenzie, the head of the Empire Section of the Federation, has left for the West Indies in company with Sir Edward Dayson. At the conference the whole trade policy and development of the islands will come under review, especially their relations to the United Kingdom.

Buenos Aires Municipal Council has opened a competition in connection with the design of a suitable switch which shall render electric tramway cables harmless in the event of breakage. According to the "Board of Trade Journal" schemes, which are to be presented within six months from Oct. 30, 1919, must be in writing and sent to the "Mesa de Entradas" of the Intendencia Municipal, accompanied by plans and descriptive memoir. The testing of the apparatus will be carried out by the Honorary Technical Committee appointed by the Municipal Executive. The Technical Committee shall not only take into account the efficiency of the apparatus at the time of the testing, but also any guarantee of permanent efficiency when subject to atmospheric or other influence. The trials are to be carried out on cables of the electric tramways of the Municipality. The expenses connected with the competition are to be borne by the competitors *pro rata*.

Dinners and Socials.

The Bury (Lancs.) electricity works staffs held their annual dinner and social last week at the Royal Hotel. Mr. S. J. Watson, borough electrical engineer, proposed the toast of "The Electricity Committee," and the chairman, Councillor Holt, replied.

Our contemporary "Aeronautics" is giving a dinner at the Connaught Rooms, London, on Thursday, Feb. 26, in honour of the survivors of the first hundred British aviators and the pioneers of aviation in Great Britain. Major-General the Right Hon. J. E. B. Seely, C.B., C.M.G., D.S.O., M.P., late Under-Secretary for Air, will preside. In connection with this dinner "Aeronautics" publishes an interesting list of the survivors of the first hundred British aviators and pioneers. In compiling this list they have adopted the formula that a pioneer is one who in the early years sacrificed time, or means, or safety, and that the end of 1910 was the general period when pioneer work came to an end.

A reunion dinner, organised by the ex-service employees of the British Thomson-Houston Company (Coventry Branch) was held on the 23rd inst., when about 50 sat down. After an excellent repast, an enjoyable toast list and musical programme was run through. Mr. F. Betts presided, and among those present were Mr. R. Dumas (Works Manager), Mr. W. C. Groocock (Assistant Works Manager) and Mr. F. W. Naylor (Chief of the Accountants Department). After the toast of "The King" had been honoured, the silent toast to "Our Glorious Dead" was observed, and the names of the 12 late employees (of the Coventry works) who had made the supreme sacrifice were read.

Mr. O. A. Pallett, who proposed the Toast "The Company," said the ex-Service men much appreciated the consideration shown by the firm, and the way in which they had reinstated all who had returned. Mr. R. Dumas responded, and said he was pleased to see so many demobilised men there from the Coventry works.

On the 22nd inst., the directors and management of Callender's Cable & Construction Company gave a welcome home to all the men now in their employ at the Anchor Cable Works, Leigh, who served in H.M. Forces during the war. The invitations included the wives and children (over 14 years), members of the various committees representing the employees, and those who administered to the welfare of the men and provided for the comforts and entertainment of their dependents. To feed and entertain a family party of over 300 is no mean task, but the resources of the Anchor works management, assisted by Miss Casstles (Lady Welfare Supervisor) and other willing workers, proved equal to the occasion. The event commenced at 6 p.m. with a "high tea." Prior to the entertainment which followed, Mr. Bowyer, J.P. (works manager), referred to the fact that that was the fourth occasion on which the firm had entertained the service men and their dependents, and this time they had the great pleasure of welcoming home the boys for whose return they had eagerly looked forward for five years. On his own behalf, and all associated with him, he gave them a very hearty welcome.

Sir Tom Callender, who was received with loud cheers, expressed great pleasure at being present on that memorable occasion. In assuring the boys of a hearty welcome, he said that, out of the 856 Callender's employees who had served in the war, no less than 260 joined the various branches of H.M. Forces from the Anchor Works. From the numerous letters and reports received, he found that they had served their King and country in almost every part of the world in which the war raged. Some had received distinguished honours, but no fewer than 27 Anchor men had made the supreme sacrifice, to the relatives of whom he offered his firm's sincere sympathy. He was pleased to say that every pre-war employee of the Anchor Works who had been spared had been reinstated, and the remainder of the pre-war employees who had yet to return would be similarly provided for. One hundred and two "service" men were now employed at Leigh. To those present who had served their King and country and made such sacrifices he extended his heartfelt gratitude and a most hearty welcome. The firm were also grateful to those who had enabled them to carry on during the war.

Gunner Wm. Hampson, who had both feet blown off by a shell, and who is regarded as one of the most optimistic and cheerful service men employed at the Anchor Works, proposed a vote of thanks to Sir Tom Callender, to Mr. Bowyer and to the management for the splendid welcome they had had that night, and this was seconded by Second-lieut. John Hodgson.

Sir Tom Callender having briefly replied, Mr. C. Pipkin, with whom were associated Mr. Howard Foulds and Mr. Hunter, all of Callender's London office, led "three cheers for the boys who had returned" on behalf of the London contingent. An excellent entertainment followed, and from 9 to 11 p.m. there was dancing.

Miscellaneous.

The last large building site in Aldwych has been secured by the directors of the Agricultural and General Engineers, Ltd., for the erection of commodious offices and showrooms.

At the Sir John Cass Technical Institute on Feb. 3, Lieut.-Col. P. S. Lelean, C.B., will distribute the prizes and certificates gained by students during the past session, and also deliver an address on "Applied Science in Gas Warfare."

The results of the recent examinations of the Institute of Chemistry are as follows: For Fellowship—In metallurgical chemistry branch, G. B. Brook; chemistry of food and drugs, fertilisers and feeding stuffs, soils and water, F. F. Beach, M.A., B.Sc. For the Associateship—In organic chemistry, H. H. Barber, B.Sc., L. P. McHatton, A.R.C.S., and H. C. S. de Whalley; in chemistry of food and drugs, fertilisers and feeding stuffs, soils and water, John Haycock and Miss E. E. Sparling.

Tenders Invited and Accepted.

Edinburgh Corporation invite tenders (by Feb. 9) for an overhead travelling crane.

Tenders are required by Feb. 7 for wiring the Cheltenham General Hospital for electric lighting. Specifications from the Secretary.

Stockton-on-Tees Electricity Committee want tenders by Feb. 5 for six months' supply of stores. Forms of tender from the Electrical Engineer.

Ayr Corporation require tenders for electric lighting work in connection with the erection of six blocks of dwellings. Schedules from Mr. J. K. Hunter, 51, Sandgate, Ayr.

Greenock Corporation require tenders by Feb. 3 for electrical installation work in 114 semi-detached houses. Schedules may be obtained at the Office of Public Works, Municipal-buildings, Greenock.

Aberdeen Electrical Committee require tenders for two water-tube boilers, superheaters, economisers, &c. Specifications from the City Electrical Engineer, Mr. J. Alex. Bell, and tenders by noon Jan. 31.

West Ham Corporation require tenders by 4 p.m. Feb. 24 for erection and supply of a refuse destructor and steam-raising plant Specifications from the Borough Engineer.

Wallasey Corporation require tenders by Jan. 31 for a 5,000 kw three-phase turbo-alternator, water-tube boiler, economiser, feed pump, 500 kw. rotary converter and e.h.t. switchgear. Specifications from the Borough Electrical Engineer.

Tenders are invited (by Feb. 11) for the supply of Telephone material (schedules 539 and 540) to the Postmaster-General's Dept., State of South Australia. Tender forms, &c., from the Commonwealth Offices, Room 406, Strand, London, W.C. 2.

The Metropolitan Water Board require tenders by 11 a.m. on Feb. 20 for three, six or 12 months' supply of stores, including electric lamps, electric wire and accessories, oils, &c. Forms of tender from the Chief Engineer, South-place, Finsbury, London, E.C.2.

The Midland Railway Company, Northern Counties Committee (Ireland) require tenders by Feb. 5 for 12 months' supply of telegraph ironwork, wire, batteries, electric lamps, carbons, &c. Forms of tender from the Stores Superintendent, York-road Station, Belfast.

Belfast Tramways Committee require tenders by Feb. 14 for the supply of electrical accessories, copper strip, lamps, insulating tapes, carbon brushes, controller fingers, trolley wire, &c. Forms of tender from the General Manager, Napier-street, Sandy-row, Belfast.

Tenders are invited by 3 p.m. of Feb. 10 for the supply and erection of 340 accumulators required by the Postmaster-General's Department, Western Australia. Tender forms from the office of the High Commissioner for Australia, 406, Australia House, Strand, London, W.C. 2.

Palmerston North (New Zealand) Council require tenders by 4 p.m. March 2 for the supply of two 400 h.p. pressure producers and auxiliaries, 3,000-volt generating sets, converters, battery switchboards, &c. Specifications can be inspected at the Department of Overseas Trade (Room 40), 35, Old Queen-street, London, S.W.1.

The Deputy Postmaster-General, Adelaide (S. Australia), invites tenders by noon Feb. 11 for the supply of protective apparatus (adhesive tape and arrester micas) (schedule 539); and telephone parts (schedule 540) for the Australian Commonwealth Postmaster-General's Department.

Aldershot Urban Council invite tenders for geared turbine and generator, condensing plant, circulating and other pumps, water-tube boiler and super-heater, and armoured, lead-covered, paper-insulated feeder and pilot cables. Particulars from the electrical engineer, Mr. F. Garside, and tenders to the clerk to the council, Mr. D. Llewellyn Griffiths, Municipal-buildings, Grosvenor-road, Aldershot, by Feb. 17.

Tenders are invited for the supply and delivery in Melbourne of two 2,000-kw. rotary converters and h.-t. and d.-c. switchgear. Specifications, &c., may be obtained from the Agents of the City Council, Messrs. McIlwraith, McEacharn & Company Proprietary, Ltd., Billiter-square-buildings, London, E.C. 3. Tenders to the Town Clerk, Town Hall, Melbourne, by 2 p.m. April 12.

Nelson Council has accepted the tender of the Brush Electrical Engineering Company for the supply of additional generating plant, &c. There are many applications for power from cotton mills and factories, and 150 people are waiting for connection. The estimated expenditure on the extensions is £47,600.

Bournemouth Corporation recently ordered 20 tramcar bodies and trucks from the Brush Electrical Engineering Company at £39,378. The order for the motors and electrical equipment was given to the British Thomson-Houston Company at £17,316; and for the track and electric equipment and spares to the Metropolitan Vickers Electrical Company at £9,240.

Manchester Corporation has accepted the following tenders:—Williams, Harvey & Co., block tin; Hadfields, Ltd., Edgar Allan & Company and Titon Track Work Company, Special Electric Company, tramcar motors; Holden & Brooke, Ltd., one set of electrically-driven centrifugal pumps at Whitworth-street West pumping station licence to sub-let the motor and switchgear to the Metropolitan-Vickers Electrical Company; Priestman Bros., Ltd., supply and delivery at Bloom-street Station of an automatic grab; Doulton & Co., blue cable cover tiles; John Russell & Company, steam and gas fittings for three months; Callender's Cable and Construction Company, non-disconnecting straight joint boxes; Compression Starter and Switchgear Company, cable.

Institution Notes.

Mr. Edgar S. Barralet will deliver an amusing lecture at the Batti-Wallahs informal meeting on Feb. 4, at the Victoria Mansions Restaurant, Victoria-street, time 6.30 for 7 p.m. Tickets (including course meal, 5s. 6d.) from hon. entertainment secretary, Mr. A. J. Greenly, 37 and 38, Strand, W.C. The chair will be taken by Mr. M. S. Chambers.

What should prove an instructive as well as interesting series of lectures dealing with industrial problems have been arranged to be given at the Carpenters' Hall, Throgmorton-avenue, under the auspices of the Industrial League and Council. Sir George Paish, financial expert, has promised to give a lecture almost as soon as he returns from America on "A Defence of Capitalism." Anyone desiring to attend the lectures can obtain particulars, with tickets, from the Secretary to the League and Council, at 82, Victoria-street, S.W.1. "The Industrial Situation" is the title of an address which is to be given by the Right Hon. W. Adamson, M.P. Mr. G. J. Wardle, C.H., M.P., Parliamentary Secretary to the Minister of Labour, is due to give an address on "Industrial Unrest and Whitley Councils"; and a lecture to be given by Mr. T. E. Naylor will deal with "Trade Unionism and Output."

At a special meeting of the Royal Society on the 22nd inst. the Prince of Wales was admitted a Fellow. The President (Sir Joseph Thomson) occupied the chair, and there was a large attendance. After a lecture by Prof. W. H. Bragg on the progress made during the war in detecting submarines by sound, the Prince of Wales thanked the fellows for the great privilege of admission as a Fellow of that ancient and distinguished Society. He would like to join with them in thanking Prof. Bragg for his very interesting lecture. He had an opportunity in France of seeing some of the wonders of sound ranging of which they had heard that day. He realised the great steps that science had made during the war and the value of so many new discoveries and their application. Never was it so necessary to promote and foster the scientific research which was the business of the Royal Society, and he assured them of his continued great interest in all that work.

Obituary.

We regret to record the death of Dr. Cecil R. C. Lyster, who was until recently superintendent of the electro-therapeutic department of the Middlesex Hospital. Deceased was a pioneer in X-ray investigation, particularly in relation to the treatment of cancer, and through exposure to the rays in the early days of research, he himself contracted the disease.

We also regret to announce the death of Ald. Brown, chairman of the Hull Telephone Committee for the past 20 years.

Personal and Appointments.

Prof. T. Loveday, of Armstrong College, Newcastle-on-Tyne, has been appointed Principal of the Southampton University College at £1,000 per annum.

Swansea Technical College Committee has appointed Dr. T. Franklin Sibly, Professor of Geology in Armstrong College, to be Principal of the University College of Swansea at a salary of £1,500 per annum.

Mr. W. H. Taylor, A.M.I.E.E., general manager of the Western Australia Government tramways and electric supply undertaking at Perth (W.A.) has been promoted to the rank of Commissioner.

Owing to health reasons Mr. Peter Fisher has been compelled to tender his resignation as manager of the Dundee Corporation tramways, but he is to be retained by the Tramways Committee as a consultant at a fee of £200 per annum.

The members of the Glasgow Branch of the Electrical Contractors' Association of Scotland have presented a silver salver and purse and cheque to Mr. James M. Davies on the occasion of his retirement as secretary to the Association. Mrs. Davies has also been presented with a pendant.

Commander C. Hawkes, R.N., has been appointed professor of Engineering at Armstrong College, Newcastle, in succession to Prof. R. L. Weighton, who is retiring. Commander Hawkes has recently been engaged on experimental work in connection with oil engines, and for the last two and a half years has been superintendent of the Admiralty Engineering Laboratory.

The many friends both in England and in Shanghai of Capt. F. L. Lawrence, R.F.A. (works manager of Chamberlain & Hookham, Ltd.), will be interested to know that the Military Cross awarded to him for distinguished service on November 6 and 7, 1918, while in action near Mons, was presented to him at the recent local investiture held by H.R.H. Prince Henry at the Birmingham Town Hall.

Appointments Vacant.

A charge shift engineer is required at the Greenwich generating station of the London County Council. Salary £250—£10—£300 a year subject to war bonus of 20 per cent.+£90. Applications to the Clerk of the Council, County Hall, Spring-gardens, S.W.1, by 4 p.m., Feb. 2.

The Ministry of Munitions requires instructors in electrical and mechanical engineering, applied chemistry, preliminary technical courses, &c for convalescent centres. Applications to the Secretary of the Ministry, Treatment Training Branch, Smith-square, London, S.W.1, by Feb. 9

Catalogues, Price Lists, &c.

In list No. 155, of Mr. H. C. Slingsby, 142-6, Old-street, London, E.C.1, particulars are given of a number of jack trucks, elevating trucks, and skids, crabs, portable cranes and other labour saving devices.

The City Electrical Company, of Emerald-street, London, W.C.1, send us a coloured calendar with monthly tear-off slips, and a reproduction of a picture by Jan Van Beers.

The Western Electric Company has issued leaflets notifying that the prices of the telephone instruments and apparatus listed in section 4,050 of its catalogue have been increased from 33⅓ to 60 per cent., while those of apparatus lists in section 4,060 have advanced from 33⅓ to 66⅔ per cent. In a pamphlet issued by the Western Electric Company particulars are given of the company's Omniphone Equipment for theatres, schools, churches, lecture halls, &c. The main features of the equipment are the transmitter, which is exceedingly sensitive and placed in a convenient position, and the receiver which can be placed throughout the seats wherever needed. The instrument was described in the Electrician for Aug. 15, 1919.

We have received a neat vest pocket calendar, which is being issued by the Lamp and Wiring Supplies Department of the British Thomson Houston Company, Mazda House, 77, Upper Thames-street, E.C.4. It reminds recipients that Leap Year provides an extra day for the enjoyment of the benefits associated with Mazda lamps and lighting. The calendar, which is printed in two colours can be overprinted and supplied in quantities to electrical contractors.

Like several other electrical firms, the British L.M. Ericsson Mfg. Company, Beeston, publishes a monthly house journal. The January issue of the "Ericsson Review," which is a special Christmas number, contains, apart from domestic items of news, interesting miscellaneous and popular technical articles, some of which possess literary merit. The magazine is for employees, old members of the staff and friends of the company, and is run by an editorial board voluntarily in their own time, any profits accruing going to improvements in the magazine.

In a striking poster (measuring 26 in. by 21 in.) issued by Fuller's United Electric Works, Ltd., particulars and prices are given of "Sparta" batteries for starting and lighting. The poster, which is printed in colours, contains a table showing types employed for American cars and also a schedule of batteries (with prices, sizes, capacity, &c., for starting and lighting. The company supplies "Sparta" batteries in all voltages and capacities for every type of starting set, both English and American. Diagrams showing three types of cell assembly are included in the poster which is being distributed among motor garages, &c.

In a showcard of novel and attractive design, which is being issued by the General Electric Company, the merits of Osram (G.E.C.) automobile type lamps are brought prominently before the public. The card is 20 in. wide by 30 in. deep, so that ample space is available for a bold design, executed in several colours, showing a dark country lane with a motor car travelling along it towards the observer. The beams of white light, in correct focus, emitted by the head lights show up in contrast with the dark surroundings. The merits of Osram (G.E.C.) automobile type lamps, particularly as regards long life, ability to withstand vibration and efficiency, are briefly set forth. At the bottom of a pocket provision is made for the reception of the Osram (G.E.C.) motorists' road map. The map itself is mounted on canvas. The main roads are shown in red and in the forefront a route guide is given. For garages, repairers, motor dealers and electricians in England and Wales, the map is of this area, for those situated in Scotland a map of Scotland is provided and similarly for Ireland.

A handsome and well-illustrated catalogue of 80 pages on Overhead Electric Power Transmission Lines has been issued by Messrs. Johnson & Phillips, Ltd., Charlton, London, S.E. In view of the developments in electric power distribution, which are bound to take place in the industrial and rural areas of this country and of the increase in hydro-electric transmission in the Colonies and elsewhere, the issue of the publication is most opportune. Unlike ordinary catalogues, it contains a number of tables, original engineering data, &c., which will prove very useful to station and mains engineers, &c. Commencing with an introduction which puts the case for overhead transmission concisely and clearly, the Board of Trade Regulations for overhead and high pressure lines, &c., are reproduced, and these are followed by tables giving data for solid hard-drawn and stranded copper and aluminium conductors, a table of voltage drop on lines, with valuable data on transmission line problems, spacing of conductors, sag and span of overhead conductors, &c. Section II. is devoted to poles (wood, steel and ferro-concrete) and Section III. to insulators. Space is also devoted so the question of guarding, to line disturbances and surge protective devices, telephone wires on power lines, switchgear, transformers, cables, terminal boxes, &c. Copies of the catalogue, which contains much original and useful information can be obtained from the firm at 10s. 6d.

Messrs. Johnson & Phillips have also issued a pamphlet which gives illustrated particulars of the design and construction of their unit type ironclad Switchgear and Distribution Boards. The unit box is of substantial yet artistic construction; the chamber containing the switches, fuses and bus bars is cast in one piece, but a cover is provided for the bus-bar chamber separate from the cover for the switch and fuses. The standard box is arranged for single V.I.R. distributor cables, but a sealing chamber is provided for hygroscopic cables when used. The whole design is simple and compact, with liberally rated current carrying parts. Special boxes can be supplied for switches or fuses according to customers' requirements.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

135,523 Baker. Variable electric resistances. (18/1/18.)
135,874 Beaver & Claremont. Electric cables. (12/3/17.)

1918 Specifications.

116,270 Bosch Akt.-Ges. Distributors for high-tension ignition devices. (26/5/17.)
116,886 Nobuhara. Rotary electric machines. (16/5/18.) (Convention date not granted.)
120,203 Remy Electric Co. Electric ignition apparatus for internal-combustion engines. (19/9/17.)
121,285 Electro Steam Radiator Co. Electric vaporisers and heaters. (30/11/17.)
121,474 Hultman. Electric selectors for telephone systems. (11/12/17.)
121,596 Westinghouse Lamp Co. Filaments for electric lamps. (19/2/17.)

Consists in intimately mixing with the refractory metal from 2 to 7 per cent. by volume (2·5 to 10 per cent. by weight) of silica and 1-4 tenths per cent. by volume (0·05 to 2 per cent. by weight) of thoria.

135,528 Dessauer. High-tension electric transformers. (23/4/18.)
135,533 B. T.-H. Co., Taylor, Clough & Whitaker. Alternating current dynamo-electric machines. (23/8/18.)
135,534 B. T.-H. Co. & Pollock. Dynamo-electric machines. (3/9/18.)
135,540 Rodriguez. X-ray apparatus. (27/9/18.)

In this invention two rotating obturating discs are provided synchronously operated. Their operation is effected by an electro-motor operating through flexible shafts and this electro-motor may work synchronously with the interrupters of the primary circuit of a transformer in such a manner that alternately with each obturation of the openings exposed by one of the rotating discs there is an issue of current into the X-ray tube.

5,573 Real. Utilisation of wind power for the generation of electricity. (23/11/18.)
35,635 Western Electric Co. Circuit arrangements for the reduction of static interference in radio receiving stations. (6/12/18.)
135,639 Moore. Electric metallurgical furnaces. (7/12/18.)
135,665 Blunt. Magnetic grab or hoist for cranes, derricks and the like. (16/12/18.)
135,667 Pollak (Fabbrica Isolatori Livorno.) High-tension insulators for use in electric supply systems. (17/12/18.)
135,669 Ware (Fabbrica Isolatori Livorno.) Insulators for high-tension electric cables. (19/12/18.)
135,672 Fagerlund. Electric time switches. (23/12/18.)
135,673 Benvenuti & Cigolini. Electric switches. (24/12/18.)
135,674 Waring & Waring. Electric furnace. (31/12/18.)
135,815 Elektro-Osmose Akt. Ges. (Graf Schwerin Ges.) Method of and apparatus for charging material to electro-osmotic apparatus for removing liquids from sustances. (20/10/17.)
135,895 Eckersley. Electro-magnetic wave transmitting and receiving systems. (5/5/19.)

A system wherein the earthing connection of the transmitter consists of two paths each containing an inductance and a capacity, one path tuned to the transmitted wave length and equal in capacity and inductance to the aerial circuit, the other together with the aerial inductance tuned to the received wave length and coupled to the receiver.

135,896 Murray & Robinson. Electro-magnetic wave navigational arrangements. (4/11/18.)

Means are provided whereby the direction of the source propagating the waves can be ascertained with accuracy by a receiving station within range, for instance a vessel at sea, or an aircraft, which direction is then useful for purposes of navigation of said craft.

135,905 Bibby. Electric arc shaft furnaces. (28/11/18.)
135,910 B. T.-H. Co. & Wedmore. Protective devices for alternating electric current distribution systems. (29/11/18.)
135,922 Read & Bransom. Method of and apparatus for the control of electric supply plant. (2/12/18.)
135,926 Cocking & Hean. Electrical equipment of motor-vehicles, boats and the like. (3/12/18.)
135,932 B. T.-H. Co. & Clinker. Wireless receiving gear. (3/12/18.)
135,951 Mossay. Electrically propelled trucks, tractors and like vehicles. (5/12/18.)
135,953 Joubert. Assembling and supporting tubular posts for carrying electric insulators. (6/12/18.)
135,964 Browder. Electric heater for automobile radiators and water storage tanks. (11/12/18.)
135,971 Davis & Son & Dearle. Electric ringing keys. (16/12/18.)

1919 Specifications.

23,086 Akt. Ges. Brown, Boveri et Cie. High-tension distributors for electric ignition apparatus. (4/2/18.) (Addition to 114,825.)
125,392 Smits. Electrical device for heating liquids. (5/4/18.)
131,895 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Mattscahppij. Telephone switchboard and plug fittings. (27/8/18.)
133,023 Holslag. Indicating means for arc welding, cutting or reducing apparatus. (21/9/18.)
135,111 Jackson Mellersh. (Taylor.) Radio-telegraphic transmission systems. (4/4/19.)

The system includes an antenna circuit ,an inductance or loading coil in said circuit, a plurality of sector circuits inductively connected to said inductance coil, and means for opening and closing the sector circuits.

135,122 Shepherd. Electrical generators and electric motors. (2/5/19.)
135,125 Sundberg & Thomasson. Process for manufacturing prue electrolytic copper from cement copper. (6/5/19.)
135,127 Johnson & Phillips & Pearson. Projector arc lamps. (8/5/19.)
135,136 Armstrong. Electric chain-welding machines. (28/5/19.)
135,146 Jordan. Electric terminal connectors. (23/6/19.)
135,150 Hope. Electric lighting of machines driven by electric motors. (21/3/18.) (Divided application on 4,990/18.)
135,157 Brown. Apparatus employing variable electric resistances. (13/8/18.) (Divided application on 13,167/18.)
135,379 Rdwe, Smith & Holland. Electric fuses for blasting. (29/1/19.)
135,389 Western Electric Co. Protective devices for electrical circuits. (14/2/19.)
135,392 Wright & Humphreys. Electric motors for variable-speed transmission. (21/2/19.)
135,409 Gruber. Method of and arrangements for cooling high-speed dynamo-electric machines. (26/3/19.)
135,416 Automatic Telephone Mfg. Co. (Automatic Electric Co.) Impulse-sending devices applicable to automatic telephone systems or the like. (14/4/19.)
135,438 Glasson. Electric circuit connecting devices. (11/6/19.)
135,441 Sansom. Automatic signal buoy and automatic wireless transmitter mechanism. (20/6/19.)
135,695 Lucas, Breeden & Ireland. Electric starting mechanism for internal combustion engines. (23/1/19.)
135,734 Rawcliffe. Electric light fittings. (6/3/19.)
135,747 Brittain. Rotors for dynamo-electric machines. (4/4/19.)
135,764 Brecknell, Munro & Rogers & Willis. Apparatus for lamp signalling in overhead wire systems of electric traction. (2/5/19.)
135,779 Berry. Electric fires. (26/5/19.)
135,801 Garwood. Electrical measuring instrument of the moving coil type. (5/7/19.)

Companies' Reports, &c.

Mr. Louis H. Kiek has been elected a director of the Vera Cruz Electric Light, Power and Traction Company, Ltd.

An interim dividend at the rate of 10 per cent. per annum (tax free) has been declared by Stothert & Pitt, Ltd., for the half-year ended Dec. 31

The Kaministiquia Power Company has declared a dividend of $2 per share (at rate of 8 per cent. per annum) on the common stock for the quarter ending Jan. 31.

The Metropolitan Railway Company has declared a dividend on the ordinary stock for the past half-year at the rate of 1½ per cent. per annum, making 1¼ per cent. for the year. A sum of £40,000 is placed to general renewals and £20,000 is carried forward.

Marconi's Wireless Telegraph Company, Ltd., announces payment of the following dividends on Feb. 2:—On the seven per cent. cumulative participating preference shares, a dividend for the year 1919 of 7 per cent., and on the ordinary shares an interim dividend for the year of 10 per cent., less tax.

Accumulators, Ltd., is being wound up voluntarily for the purpose of reconstruction, and the liquidator (Mr. W. J. Matthews), 1, Laurence Pountney-hill, London, E.C., has been authorised to consent to the registration of a new company to be named Accumulators of Woking, Ltd., and to enter into agreement with such company. A meeting of creditors will be held at Maybury-hill, Woking, on Feb 7.

The directors of Mather & Platt, Ltd., propose to capitalise and distribute £450,000 of the undivided profits standing to the credit of the reserve and other accounts. They intend to use this amount for paying up 450,000 new ordinary shares of £1 each, which will be distributed as fully paid amongst the holders of the existing ordinary shares at the closing of the transfer books on Feb. 13, in the proportion of three new shares in respect of each four existing shares. It is also proposed to increase the capital to £2,500,000 by the creation of 1,500,000 new shares of £1 each, of which 450,000 will be distributed as above, and the remaining 1,050,000 reserved for future issue.

During the year ended Dec. 31 the number of passengers carried on the East London Railway Company was estimated at 12,721,929, against 10,564,306 (in 1918), exclusive of 2,278 season ticket holders. At an average rate of 1·27d. per passenger, receipts amounted to £67,320; season tickets, £5,589; parcels, &c., as in 1913, £897; and goods train traffic as in 1913, £15,864, making a total of £89,975. The figures are arrived at without taking into account the 50 per cent. increase in fares to and from New Cross (which fares are in value about 25 per cent. of the total East London bookings) nor the increased season ticket rates. Fifty-six per cent. of £89,975 would give the company £50,386, instead of the minimum of £30,000 per annum.

At the recent meeting of the British Burmah Petroleum Company, Ltd., the chairman (the Hon. Lionel Holland) stated that in making an issue of shares they had in view, as one main motive, the provision of capital for the electrification of their plant on the Yanangyaung oilfields. The consumption of oil for fuel to supply the power needed for drilling and pumping in the Twingon and Beme areas had become excessively and increasingly wasteful and costly. They estimated that the saving to be derived from electrification would justify a far larger capital outlay than they were called upon to incur under the scheme that had been agreed upon. For several years the Board had recognised the need of an electric power installation. The arrangements which they were entering into were likely to give better and more economical results than if they had been called upon to bear the whole capital and working costs of an installation to supply power for the wells and requirements exclusively of their own company.

New Companies.

ACCUMULATORS OF WOKING, LTD. (163,120)—Private company. Reg. Jan. 22, capital £35,000 in £1 shares, to take over the business of Accumulators Limited and to carry on the business of engineers, machinists, manufacturers of and dealers in electric batteries and accumulators, &c. First directors are H. P. Martin, H. Fulton, G. H. Handasyde and L. C. Rawlence. Reg. office: Maybury Hill, Woking.

ALLEN & SIMMONDS (READING), LTD. (162,790).—Reg. Jan. 14, capital £350,000 in £1 shares, to take over the business of Allen & Simmonds, Ltd., and to carry on the business of general and marine engineers, aero and electrical engineers, &c. First directors are R. Allen, C. Allen, F. A. Simmonds, B. Tull, R. E. Evans, A. Wardill and G. F. Craven, M.I.E.E. Secretary, R. E. Evans. Reg. office: 42, De Montford-road, Reading.

BARRETT & WRIGHT, LTD. (162,602).—Private company. Reg. Jan. 9, capital £13,000 in £1 shares, to take over the business of Barrett & Wright, and to carry on the business of electrical and mechanical engineers, &c. First directors are J. Barrett and R. F. Wright. Reg. office: 19, Bartholomew-close, E.C.

BRITISH ELECTRIC SUPPLIES, LTD. (162,609.—Private company. Reg. Jan. 9, capital £50,000 in £1 shares. To take over the business of the Britannia Lamp and Accessories Company, &c.

G. P. DENNIS, LTD. (162,532)—Private company. Reg. Jan. 7, capital £5,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical, mechanical and general engineering supplies, &c. First directors are G. P. Dennis (governing director) and Mrs. L. Dennis. Reg. office: 66, South John-street, Liverpool.

EBONESTOS INSULATORS, LTD (162,480)—Private company. Reg. Jan. 6, capital £100,000 in £1 shares, to take over the business of makers of moulded "Ebonestos" insulators, turners and workers in hard woods, ebonite and fibre, &c., carried on as the Ebonestos Mfg. Company, and to enter into an agreement with J. B. Alexander and B. Weaver. First directors are J. B. Alexander and B. Weaver. Reg. offices: 127, Pomeroy-street, New Cross, S.E.14.

ELECTRIC MOTORS (SOUTH WALES), LTD. (162,293).—Private company. Reg. Jan. 1, capital £20,000 in £1 shares, to carry on the business indicated by the title. First directors are W. H. Diamond, (chairman), M. Wideman, T. Diamond and E. C. R. Mackadam. Reg. office: 1, Wood-street, Cardiff.

ELECTRIC REPAIRS, LTD. (162,566)—Private company. Reg. Jan. 8, capital £1,000 in £1 shares, to carry on the business indicated by the title. First directors are W. Boffey, W. H. Scott, B. F. Waiter and T. Withers. Reg. office: Old Bilston-road, Wednesbury.

ELECTRO-DYNAMIC CONSTRUCTION COMPANY, LTD. (162,481)—Private company. Reg. Jan. 6, capital £10,000 in £1 shares, to acquire the business carried on by N Pensabene, and to carry on the business of electrical engineers, workers in metals, contractors for the supply of electrical plant, &c. First directors are N Pensabene (permanent managing director) and E. J. Timberlake. Reg. offices: 4, New Cross-road, S.E.

HALLIWELL & GOOD, LTD. (162,167).—Private company. Reg. Dec. 30, capital £3,000 in £1 shares. Objects: to carry on the business of electricians, mechanical engineers and manufacturers, &c. Permanent directors: C. N. Good and J. R. Halliwell (chairman and managing director). Reg. office: 61, High-street, Manchester.

HART COLLINS, LTD. (162,680).—Private company. Reg. Jan. 10, capital £5,000 in £1 shares, to take over the business of Cyril Hart Collins, and to carry on the business of manufacturers of and dealers in motor cars, manufacturers of electrical appliances, &c. First directors are C. Hart Collins (managing director) and Mrs. H. M. Collins. Reg. office: 5, Bessborough-mews, Bessborough-street, Westminster, S.W. 1.

MICA & ASBESTOS INSULATING COMPANY, LTD. (162,495)- Private company. Reg. Jan. 6, capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in mica, asbestos, carta, insulating cloth, enamelled wire, &c. Solicitors: Goldberg & Barrett, 2-3, West-street, Finsbury-circus, E.C.

MOUNTAIN RAILWAYS LTD. (162,381)—Private company. Reg. Jan. 2, capital £12,000 in £1 shares (6,000 preference), to obtain from the French and Italian Governments concessions for the construction and working of a railway from Briancon, in the Hautes Alpes Department of France, to Oulx, in Piedmont, Italy, across the Mont Genevre Pass of the Alps, and to adopt an agreement with G. N. Fell. Solicitors: Wilkinson, Raikes & Son, 34, Nicholas-lane, E.C.

RENEW LAMP COMPANY (EASTERN), LTD. (162,824).—Private company. Reg. Jan. 14, capital £5,000 in £1 shares, to carry on the business of refillers of incandescent electric lamps, etc., and to enter into an agreement with Alladin Renew Electric Lamp Corporation, Ltd., and J. M. Moore, D.Sc. First directors are: J. M. Moore, E. S. Saunders and J. S. W. Milne. Reg. Office: 3-4, Great Winchester-street, E.C.

TELEPHONE & MICROPHONE COMPANY, LTD. (162,831).—Private company. Reg. Jan. 14, capital £10,000 in £1 shares (5,000 cumulative participating preference), to carry on the business indicated by the title. First directors are R. and J. R. Scraby. Reg. office: Throwley-road, Sutton, Surrey.

Prices of Metals, Chemicals, &c.

Tuesday, Jan. 27.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£123 0 0	—	—
Electro Wirebars...	..	£123 10 0	£0 10 0	—
H.C. wire basis......	per lb.	1s. 4$\frac{9}{16}$d.	—	—
Sheet	,,	1s. 6d.	$\frac{1}{16}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8$\frac{9}{16}$d.	—	—
Brass 60/40—				
Rod, basis	,,	1s. 0$\frac{1}{2}$d.	—	—
Sheet, basis	,,	1s. 4$\frac{5}{8}$d.	$\frac{1}{2}$d.	—
Wire, basis	,,	1s. 3$\frac{7}{8}$d.	—	$\frac{1}{8}$d.
Iron—				
Cleveland Warrants	per ton	£9 2 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£39 0 0	—	—
Lead Pig—				
English	,,	47 10 0	—	£1 0 0
Foreign or colonial	,,	46 5 0	—	£1 7 6
Tin—Ingot	..	389 10 0	£4 15 0	—
Wire, basis	per lb.	0 4 10	1d.	—

Salammoniac.—Per cwt. 95s. and 90s.
Sulphur (Flowers).—Per ton £23.
,, (Roll Brimstone).—Per ton £22 10s.
Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £47.
Boric Acid (Crystals)—Per ton £74
Carbon Bisulphide.—Per ton £56.
Sodium Bichromate.—Per lb. 9d
Sodium Chlorate.—Per lb. 6d.

Shellac.—T.N. Orange, 890s.
Rubber.—Para fine, 2s. 7$\frac{1}{4}$d.; plantation 1st. latex 2s. 8$\frac{1}{4}$d. lb

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd, and the rubber figures by W. T. Henley's Telegraph Works, Company.

Thirty-Seven Years Ago.

[From The Electrician, Jan. 27, 1883.]

The Telephone in Paris.—Besides its ordinary working lines, the Société Générale des Téléphones has established, since its formation in 1880, 200 private lines and more than 2,000 telephonic posts, in Paris and the provinces. Mr. Hospitalier is our authority for this statement.

"Wholesale Electricity."—This is the somewhat novel title of an article in last Monday's "Times." The writer gave a brief review of the plan upon which Mr. Moulton has drawn up the provisional orders, which were entrusted to his care. As we have already treated this subject in our columns we need not refer to it at any length here.

Electric Lighting for Canterbury.—The question of the introduction of the electric light into this city, which has for some time engaged attention, was again the subject of debate on Wednesday last. The Town Council held a long consultation with the managing director and solicitor of the South Eastern Brush Company, but the consultation was unsuccessful, and the parties separated without coming to terms. A special meeting of the Council was afterwards held, at which it was decided that in order to protect the city from monoply a number of the clauses in the provisional order for which the company is about to apply should be opposed.

Electric Lighting at the Holborn Restaurant. The Holborn Restaurant, which has been thoroughly remodelled and enlarged, will, when opened, be lighted by the Edison electric light. Messrs. Ransomes, Head & Jefferies, of the Orwell Works, Ipswich, are building for this purpose two 16 horse-power engines, to be fitted with their patent automatic governor expansion gear, which has already given such excellent results in connection with the electric light. The whole arrangements are under the immediate control of Messrs. Lewis, Olrick & Company, of 27, Leadenhall-street, E.C., consulting engineers to the Edison Company. The opening of this new installation, will, we understand, take place early in February.

Electric Lighting for the City.—The Select Committee of the Commissioners of Sewers of the City of London are inviting proposals for lighting (only) portions of the City by means of electricity, with a view to applying to the Board of Trade for a license under the Electric Lighting Act, 1882. Each proposal must indicate on a plan the area or areas intended to be lighted, together with the conditions of supply, including prices, &c. No one area is to exceed an eighth of the whole city. The proposals must include the lighting of the public streets and private and other premises within the respective areas, and be subject to the provisions of the above-mentioned Act and the rules made by the Board of Trade. Proposals should be sent to Mr. Hy. Blake, principal clerk, Sewers Office, Guildhall, E.C., by the 3rd of February.

Electric Lighting at Berechurch Hall.—During the week several letters have appeared in "*The Times* referring to the lighting of Mr. Coope's mansion at Berechurch. "Enquirer" set the example by asking sundry questions as to whether it was necessary to start the engine before you could get one light, and whether you had to run it all the same if one or 200 lights were going, and more to the same effect. This Mr. Coope answered in the affirmative. Mr. Sellon contributed to the correspondence by advocating the use of secondary batteries, by means of which the constant running of the engine might be avoided and perfect steadiness of the lights ensured. In another issue of the same paper, Mr. F. Rogers asked Mr. Sellon to state "the cheapest and best plan of electrically lighting, say, a pair of semi-detached houses of the villa class."

Electrical Safety Lamps for Miners.—A correspondent, in a recent issue, asked for some information concerning the premium that has been offered by Mr. Lever, M.P., for a portable electric safety lamp for use in mines. For the benefit of our correspondent and others, we may say that Mr. Ellis Lever's address is Culdeth Hall, Bowdon, Cheshire, and that he has agreed to hand over £500 to the Central Board of the Miners' National Union, to be paid to any one inventing such a lamp. It has been provided that the offer shall remain open throughout the current year, and that the adjudicators shall be composed of "three scientists, one to be selected by Mr. Lever, one by the Council of the Royal Society and one by the Council of the Society of Arts, one person representing the mining engineers, chosen by themselves, and one person representing the workmen, chosen by the Central Board of the Miners' National Union." The above mentioned reward is to be meanwhile invested in the names of three trustees, one of whom shall be Mr. Thomas Burt, M.P., the other two to be chosen by the Miners' National Union.

Electric Lighting in London.—The Electric Lighting Committee of the Strand Board of Works intend to formulate some conditions with reference to the introduction of electric lighting into their district, which are shortly to be laid before the Board of Trade. The conditions are somewhat as follows:—That only one company should come into the district; that it should light all the district; that any private person desiring a separate service might do so on arranging with the company; that the board should control the number of hours during which the lighting should be maintained; that the charges should be 10 per cent. on the capital employed. It was suggested at the meeting at which these conditions were submitted, that the committee should be empowered, if necessary, to obtain the services of an electrical expert at a cost not exceeding 25 guineas. St. Olave's Board of Works do not think it advisable to take any steps to obtain a license. St. George the Martyr (Southwark) Vestry have contented themselves with drawing up a formal list of amendments which they will like carried out in the provisional order applied for by the Metropolitan Brush Company. St. Luke's Vestry also require some amendments in the same Company's order.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,177. [Vol. LXXXIV. No. 6.] FRIDAY, FEBRUARY 6, 1920 PRICE SIXPENCE.
By Post. 7d Abroad. 9d

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Notes.

Hydro-Electric Development.

The Paper on "Recent Advances in the Utilisation of Water Power," read by Mr. E. M. Bergstrom before the last meeting of the Institution of Mechanical Engineers, is hardly likely to have the space devoted to it by the engineering journals which the value of its contents warrants. It is so long as to be almost a text-book. It is largely descriptive. It contains a good deal which, though of interest, is not new. And it is lacking in debating points. We are only able to deal with it very briefly. Nevertheless, we recommend its perusal to our readers as something well worth doing when they have an hour or so to spare. In this issue we also publish an article by Mr. S. E. Britton, the electrical engineer of Chester, in which he deals with possible hydro-electric developments in this country. As we have recently pointed out, there is no doubt room for such development, for it is a truism that we lag behind other countries in this respect. Figures given by Mr. Bergstrom show that while in the United States 28,100,000 B.H.P. of water-power is available, of which 7,000,000 B.H.P., or 24·9 per cent., has been developed, in this country only 80,000 B.H.P., or 8·3 per cent., out of a possible 963,000 B.H.P., has been similarly exploited. In Italy the percentage developed is slightly less than in the United States, while in Switzerland, as might be expected, it is rather more; but in Germany, of 1,425,000 B.H.P. available, no less than 618,100, or 43·4 per cent., has been developed. Mr. Bergstrom does not state to what period these figures refer, but they are probably not very modern, so that it is not unlikely that in those countries where development is being seriously taken in hand the showing is now somewhat better.

The Hydro-Electric Problem in This Country.

It is obvious, therefore, that there is still plenty of room for development, especially in this country. For his part, Mr. Bergstrom is optimistic about what will be done. Mr. Britton is rather inclined to be pessimistic. The one, we presume, looks upon the question from the point of view of the designer of water-power plant, irrespective of where it is to be installed. The other has had actual experience of operating a hydro-electric station in this country. It is therefore, perhaps, as well that we should accept his guidance when we wish to examine the prospects of our own hydro-electric development. As we recently pointed out, there are two factors which have militated against the extensive use of hydro-electric power—cheap coal and the remoteness of the water-power. In addition, compared with other countries, our resources are relatively small in number as well as in amount. While then our industries have been able to obtain cheap coal it has not been worth their while for the majority of them to establish factories in the wilds of Scotland, and it will be interesting to see what effect the present high price of coal will have on future policy. In addition, there is once again the bugbear of vested interests operating against the greatest good of the greatest number. As Mr. Britton points out, and we have often insisted, this is a matter which should be taken in hand without delay.

Combined Water-Power and Steam Stations.

Although the water-power available in this country is only to be found in relatively small quantities, there is one way in which it can be successfully used in certain cases—*i.e.*, in conjunction with a steam station. When Mr. Britton adopted this method at Chester in 1913 there were not lacking those who prophesied its failure. In the event it has been a complete success. The majority of the units sold are generated by water-power at a price of 0·0823d., as against 0·9308d. for those generated by steam. The capital charges per unit sold work out at 0·5943d. for steam and 0·1779d. for water-power. This demonstrates the value of utilising water-power in conjunction with a steam station, even although the proportion of water-power available is small. The scheme in its initiation was an interesting one, and it has been justified by the results obtained. With the present shortage and high price of coal, some scheme of this kind is worthy of detailed consideration; but, unfortunately, there are only a few places in the same happy position as Chester of having water-power at their doors.

Present Day Radiography.

It is a matter, not only for congratulation, but of importance, to electrical engineers that the science with which they are connected is always branching out into new fields of usefulness. Discoveries in the realms of the purest science, which seemed at first sight not to be adaptable to practical ends, have time and time again proved of the greatest technical and commercial utility. Examples of what we mean have occurred in the development of wireless telegraphy and telephony, and will, of course, be familiar to readers of The Electrician. From an article on "Present-day Radiography," by Major G. W. C. Kaye, which is published on another page of this issue, it would appear that the science of radiography is following the same lines of development. As is well known, the X rays have now been used for many years in therapeutical and surgical work, and have already played as great a part as any other branch of electrical science in improving the welfare of mankind. During the war the X-rays were found to be indispensable for this class of work, but they also found an interesting and practical application in the detection of flaws in metal and other material for munition work, and in the testing of aeroplane structures. It would therefore seem that the X-ray tube is likely to become a necessary part of heavy engineering testing apparatus, though at present a stumbling block is its inherent weakness, even in those of the most modern type. The Coolidge tube, of course, shows a great advance over the earlier apparatus, but, as Major Kaye remarks, what is now required is a super-Coolidge tube, as much superior to the ordinary Coolidge as the Coolidge is to the ordinary gas tube. No doubt work will be undertaken in this direction by radiographers, and we wish them all success in their efforts. For anything that helps the knowledge of materials used in engineering is worth the gravest consideration, and for this reason we are glad to see that the Institution of Electrical Engineers is to discuss radiographic questions at a meeting which is shortly to be held.

The Science of Colour Matching.

At the meeting of the Illuminating Engineering Society last week a discussion on colour matching by natural and artificial light was opened by Mr. L. C. Martin, who, in a Paper which he read at length, covered pretty exhaustively a good deal of ground. It was useful to have the scattered data bearing on the subject assembled, and much of the individual work recorded is of considerable merit. There was a general recognition, however, that much remains to be done, and that the art of colour matching has not yet been put on a satisfactory scientific basis. In colour matching there are two fundamental problems, which may be shortly stated as follows: The apparent colour of any object varies with the quality of the light by which it is viewed *i.e.*, certain shades of blue look entirely different when seen by north daylight than they do by the light of a half-watt lamp. The first thing to do, then, is to determine a standard of illumination by which all colours can be compared. There is, further, the difficulty of describing two very similar colours accurately when seen under the same illumination. In dealing with the first of these problems it is obvious that some sort of artificial light must be chosen as a standard, daylight being too varying in quality to be at all satisfactory for this purpose. To choose such a standard should be possible scientifically, although the problem is a somewhat complex one; care will have to be taken to specify all the necessary details, such as voltage, wattage, candle-power, &c., which have any bearing on the illumination. The standard of light by which colours have to be viewed having been determined, it will then be necessary to describe the colours accurately and arrange some method of intercomparison. The difficulty about this is that there are at present too few names for the large number of colours and varying shades of colours which are in general use. It is common to say, for instance, that a particular fabric is blue, but such a description applies equally to hundreds, or even thousands, of other shades, and depends not a little on the personal equation. It therefore seems that, for scientific purposes, we must have a more detailed nomenclature than that in use at present, and there is a good deal to be said for describing colours by numbers rather than by names. The Illuminating Engineering Society in the past has done good work in other branches of illuminating science, and we have no doubt that they will tackle this problem in the same enterprising spirit, and obtain a satisfactory solution; but before doing so it is obvious there is a great need to clear away a deal of debris which is now interfering with a proper consideration of the subject.

The Testing of Scientific Glassware.

The relation between the manufacture of glassware and the electrical engineering industry is a very close one. Any development in the former should therefore be watched by those in the latter, especially those connected with lamp manufacture and the more scientific branches of our trade. Before the war, the manufacture of the scientific glassware used in this country was largely in the hands of foreign firms. So much so that the British scientific glassware industry was practically non-existent. The war, however, allowed its wide development, it is now on a satisfactory basis, and it will be generally agreed that every step should be taken to maintain it and to increase its prosperity. One of the best ways that this can be done is by ensuring accuracy in manufacture, and we are therefore glad to see that the National Physical Laboratory has taken steps, in co-operation with the manufacturers and users of scientific glassware, to carry out the necessary tests on such apparatus. For this purpose a new building has just been completed at the Laboratory, where both class A and class B tests will be conducted. Class A tests, we may remind our readers, are designed for vessels intended to possess the highest accuracy required for scientific use; but all grades of apparatus for good commercial work should be able to comply with the class B tests if satisfactory results are to be obtained in ordinary routine analysis. Those who are interested in this subject should take an opportunity of consulting the Laboratory test pamphlet, entitled "Volumetric Tests of Scientific Glassware," which was published a short time ago. This may be obtained free of charge from the Laboratory. If this branch of industry develops as we hope it will, it will be partly because a high standard of results has been set and maintained. The National Physical Laboratory has set the standard, and it is now the duty of manufacturers to co-operate with them in its maintenance. It is essential now that we have regained this trade we should hold it against all comers

Daily Press Science.

Certain of our daily contemporaries have recently seen fit to turn from considering boxing matches and murderous assaults on inoffensive citizens to discuss other subjects of scientific interest. (We hasten to add that this is meant facetiously, for offence is sometimes taken at remarks in these editorial notes where none is intended. Also, we do not really think murder is a science. So much for explanation!) We often wonder whether the information given by the daily press on every subject is as inaccurate as it is on scientific questions. As regards accuracy, and even common sense, what they say is usually beneath contempt, and the London papers are worse than the provincial ones. It cannot be expected, perhaps, that the organisation of a daily newspaper should include someone whose business it is to prevent members of the staff making scientific bloomers; but at least scientific subjects might be dealt with by a reporter who has, say, passed the London Matriculation in science subjects. For while a man who knew nothing about football would not be sent to report a cup tie, any Dick, Tom or Harry is considered competent to "do wireless telegraphy," if it is done at all. Not only do they go wrong on questions of fact, but they make the most extraordinary deductions from inadequate premises. The latest outstanding example of this is to be seen in the comments on an innocent remark of Senator Marconi about the possible origin of certain stray signals that have been noticed for a long time by wireless telegraph operators. These are not ordinary atmospheric strays, but seem to be due to electromagnetic waves of great length. Senator Marconi was stated by our all-wise contemporaries to have said conclusively that the signals came from Mars, and round this statement, which was not made, was woven a beautiful story which almost inclines us to pay a high compliment to the imaginative powers of those concerned, were it not that we should also have to say what we thought about their scientific attainments. Scientific progress, as no one knows better than Senator Marconi himself (and no one, apparently, knows less than our daily contemporaries) proceeds half blindly. It is like a man climbing a cliff in the dark. He must grope for hand and foothold where he can, and perhaps half his attempts to obtain one that will hold him are unsuccessful. Progress in science is often made by organised guessing and speculation, and, while such guessing may be successful, it may equally often result in failure. The scientist must explore every possibility, but he must only accept those which show the likelihood of containing truth. These things, however, are outside the purview of the daily press, and, as long as the story is good, the truth of it apparently does not matter. We sympathise with Senator Marconi in the annoyance to which he has been put over this matter; but it seems to be one of the penalties of greatness to have one's statements twisted to bear a meaning entirely contrary to that which the speaker intended.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

On page 136 we give an article on "Possible Hydro-electric Development in this Country," by Mr. S. E. Britton.

In an article on "Dynamo Output Formulæ," Mr. J. K. Catterson-Smith discusses the simplification of the D^2l expression in dynamo design by the omission of the "specific electric loading." The output formula is developed so that the specific loading are both densities (p. 138).

On p. 142 an article by Major G. W. C. Kaye, O.B.E., deals with "Present-day Radiography." Recent developments, as illustrated by the Röntgen Society exhibition, are described, and the advance in the design of the Coolidge tube and in radiometallography and radiography, and their application to engineering problems, are dealt with.

On page 139 we publish an abstract of a Paper, read by Mr. E. M. Bergstrom, on "Recent Advances in the Utilisation of Water-power," before a recent meeting of the Institution of Mechanical Engineers. This deals especially with the development of the Pelton wheel, and the alterations in design which have become necessary owing to the increased use of this form of power.

On page 144 we conclude our abstract of the Paper read by Mr. J. L. Thompson on "Transformers for Electric Furnaces" before a recent meeting of the Institution of Electrical Engineers in London, and we give an account of the discussion on this Paper.

We conclude our account of the recent exhibition organised by the Physical and Optical Society of London (page 146).

The second and concluding part of a Paper by Major-General Geo. O. Squier on the result obtained by using trees as antennæ in wireless telegraphy and telephony will be found on page 147.

Our periodical article on the latest electric heating and cooking apparatus appears on page 149.

Our Leading Article this week deals with the question of protecting power stations against possible aerial attack and civil disturbances. Certain suggestions are put forward for the consideration of the authorities (page 151).

Exhibitions held or opened during the week include the Motor Show at Glasgow (page 153), the British Industries Fair at Birmingham (page 152), and the Ideal Home Exhibition at Olympia. We shall deal with the last more fully in subsequent issues.

Arrangements for the Week.

FRIDAY, Feb. 6th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Presidential Address by Prof. C. H. Lees, D.Sc., F.R.S., Paper on "Atmospheric Refraction during Total Solar Eclipses," by Sir Arthur Schuster, F.R.S. Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.—STUDENTS' MEETING.

7 p.m. At the City and Guilds (Eng.) College, S. Kensington, London, S.W. Paper on "Electric Lifts and Cranes," by Mr. F. R. Honsden, A.C.G.I.

TECHNICAL INSPECTION ASSOCIATION.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper on "The Treatment of Steel," by Mr. J. Waite, M.B.E.

SATURDAY, Feb. 7th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, London, W.1. Lecture on the Astronomical Evidence bearing on Einstein's Theory of Gravitation: Lecture II. "Displacement of Solar Spectral Lines," by Sir Frank W. Dyson, F.R.S.

MONDAY, Feb. 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH-EASTERN CENTRE.

7.15 p.m. At Armstrong College, Newcastle. Paper on "Transformers for Electric Furnaces," by Mr. J. L. Thompson.

TUESDAY, Feb. 10th.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. At Gt. George-street, London, S.W. Paper on "Experiments on the Horizontal Pressure of Sand," by Mr. P. M. Crosthwaite, B.A.I., and "Overturning Moment on Retaining Walls," by Dr. A. R. Fulton.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH MIDLAND CENTRE.

7 p.m. At Royal Victoria Hotel, Sheffield. Lecture on "The Rotherham Power Station," by Mr. E. Cross.

NORTH WESTERN CENTRE.

7 p.m. At the Engineers' Club, Albert-square, Manchester. Lecture on "A Critical Survey of Power Supply in the Rhine Valley," by Lieut.-Col. F. C. Aldous and Mr. A. E. Leigh Scanes.

SCOTTISH CENTRE.

7.30 p.m. At 207, Bath-street, Glasgow. Paper on "Transformers for Electric Furnaces," by Mr. J. L. Thompson.

WEDNESDAY, Feb. 11th.

INDUSTRIAL LEAGUE AND COUNCIL,

5.15 p.m. At the Carpenters' Hall, Throgmorton-avenue, London, E.C.2. Lecture on "The Industrial Situation," by the Rt. Hon. W. Adamson, M.P.

INSTITUTION OF ELECTRICAL ENGINEERS.—SOUTH MIDLAND CENTRE.

7 p.m. At the University, Edmund-street, Birmingham. Informal discussion on "B.E.S.A. Specification No. 72."

ASSOCIATION OF ENGINEERS-IN-CHARGE.

7.30 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "Coal Saving by Scientific Control in the Boiler House," by Mr. D. Brownlie, B.Sc.

INDUSTRIAL LEAGUE AND COUNCIL.

7.30 p.m. At the Conference Hall, Central Hall, Westminster, London, S.W. Subject: "International Exchanges and Cost of Living," by Mr. H. G. Williams, M.Sc.

THURSDAY, Feb. 12th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, London, W.1. Lecture on "Recent Progress in Applied Optics," by Prof. A. E. Conrady (Lecture II.)

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Gt. George-street, London, S.W. Paper on "The Protection of Alternating Current Distribution Systems without the use of Special Conductors," by Major K. Edgcumbe.

LIVERPOOL ENGINEERING SOCIETY.

7.30 p.m. At the Exchange Station Hotel, Liverpool. Annual Dinner.

FRIDAY, Feb. 13th.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39 Victoria-street, London, S.W. Lecturette on "Gas Manufacture," by Mr. F. E. Heenan.

SATURDAY Feb. 14th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, Piccadilly, London, W. Lecture on The Astronomical Evidence bearing on Einstein's Theory of Gravitation: "Deflection of Light in the Sun's Gravitational Field," by Sir Frank W. Dyson, F.R.S. (Lecture III.)

Possible Hydro-Electric Development in this Country.

By S. E. BRITTON.
(Electrical Engineer, City of Chester.)

Judging by the statements appearing in the daily press, it is clear that the magnitude and commercial value of the water-power resources in this country are not accurately gauged or appreciated. Many articles have appeared in print during recent years with reference to hydro-electric developments in various parts of the world where water-power of great magnitude exists. These have had the effect of establishing a general belief that this country also possesses vast water-power resources, the development of which engineers and lack of enterprise have grossly neglected to take advantage. Those who have considered our water-power resources and their commercial possibilities know that the common belief is unwarranted, and that the area and geographical condition of Great Britain is such that it cannot produce a hydro-electric scheme to compare with the large developments in other countries, or to provide a sufficient quantity of electrical energy for any of our large industries which require great power.

Water-power Resources Small.

There is without doubt in this country water-power of a magnitude which if converted into electrical energy would be of inestimable benefit and value to the domestic, agricultural and industrial life within a limited radius of the water-power resources, and also to industries which can conveniently migrate from the dense industrial areas to within the economical influence of hydro-electric generation and electric transmission.

With the exception of the resources in the mountains of Scotland and of Wales where developments of 10,000 H.P. and upwards are possible, the amount of power available at individual sites will seldom be found to produce thousands of horse-power. In the majority of cases the amount of power is considerably less; therefore, if this natural source of power is to be utilised to the fullest economical extent it must be approached from a different point of view to that which governs hydro-electric developments in countries more favourably provided with water-power resources, and the small powers here, of tens and hundreds of horse-power must be carefully considered and systematically utilised.

The density of population, the short distances between many of our towns and large villages, the possibility of greater fertility of the land, the network of railways, the influence of steam, petrol and electric vehicles have in bringing places and industries into touch with marketing centres, are conditions which appreciate the value, and make small sources of water-power in this country worthy of attention.

Industries Must Go to the Water-power.

Also the removal of industries that do not require a great deal of power, from dense industrial areas would tend to relieve the over-crowding of towns, transfer a certain number of employees to localities where the social reconstruction ideals of to-day can be more exepditiously and economically organised and bring about that desirable growth of large villages with their manifold advantages over excessively industrialised districts. These would be secured by the utilisation of the replenishing asset contained in this natural form of power, to say nothing of other benefits accruing from the conservation of coal, and the handling, transport and apparatus involved in the use of coal.

The Plea of Vested Interests.

One of the greatest, if not the greatest, deterrents to the development of water resources is the powers vested by statutes governing the control and use of water rights and access to waterways. The statutes were enacted when the desire for the preservation of various kinds of sport had a controlling right or privilege over the development of natural resources, and resulted in developments for the common good being subservient to sporting ambitions. That the enactments relating to water are detrimental to the common good, needing a general overhaul and bringing into line with the requirements of to-day, cannot be disputed.

A new era is about to begin which, if labour will allow, may be termed "the mass production period," and unless the sportsman develops the natural resources devoted to sport, so as to produce mass production in the form of food, the transfer of sporting facilities to another purpose which will provide a greater benefit for an increasing number of people is inevitable.

The Advantages of Water-power.

Water is not a wasting asset such as coal. Like air, it is a natural necessity for human, animal and vegetable life, and as such should be controlled and primarily used to produce the best result. By a cycle of natural events it is replenished; therefore expenditure on works for the utilisation of water for essential purposes is not subjected to the risk of loss due to exhaustion as are wasting assets. The risk of loss in connection with works for the utilisation of water arises principally from obsolesence and depreciation due to ageing.

There are innumerable instances of comparatively small water-power developments in use in this country, a greater number undeveloped, and a great number discarded. The tendency is to assess the undeveloped and discarded on the conditions which prevailed in the past, whereas improvements in the design and efficiency of hydraulic and electric plant, the advanced cost of labour, material and fuels, the ease with which water-power converted into electrical energy can be transmitted from the site of the power to a place where it can be most conveniently utilised, the greater variety of purposes it can thus be applied, are conditions which have enhanced the value of the derelict, and of even the smallest water-power resources in the country, to such an extent that all are worthy of investigation, and in many cases of reconstruction.

The Financial Position.

The prevailing opinion that the cost of development is too heavy, and therefore cannot be undertaken with a reasonable prospect of earning a proper return is not well founded. That view is a relic of the past, based on the experience of incomparable developments in remote parts of other countries, or developments in this country which have long since been obsolete, many of which if modernised with efficient apparatus, and used to the full would now prove valuable assets. To more clearly illustrate the accuracy of what many may be disposed to treat as an assumption, the results obtained in connection with the use of the River Dee water-power at Chester may be briefly cited.

The history of Chester relates that the water-power of the Dee has been almost continuously utilised for various purposes since 1170. Prior to the construction in 1913 of the hydro-electric works, 25,000 cubic ft. per min. of water was the maximum volume used by several under shot water-wheels, for power purposes, at an efficiency not exceeding 30 per cent. The site is within the influence of the tides. The presence of tidal water was to put the water wheels out of action for periods aggregating three months per annum, and for considerable periods, principally during the winter, when large volumes of fresh water ran off, the water wheels could not be operated owing to the height of the tail water, which, together with the effect of tides, reduced the use of the water-power by approximately six months per annum. These adverse conditions, along with improved methods of transport by road and rail, and improvements in manufacture, resulted in the use of the water-power and apparatus employed in carrying on the industries becoming obsolete, and they were eventually discarded in 1908, and the building demolished in 1910.

The investigation for the hydro-electric installation commenced in 1910, and the scheme was inaugurated in 1913. The capital expenditure incurred includes an expenditure of £3,000 for works carried out adjacent to the site to improve the amenities which do not form part of the undertaking.

Results at Chester.

The installation consists of three units, two capable of utilising 30,000 cubic ft. per min. of water when the fall is 9 ft., and generating 225 kw., and one 22,000 cubic ft. per min. and 180 kw. The efficiency of the conversion of the water-power to electrical energy is 66 per cent. The aggregate of the periods when the installation is stopped owing to tidal water is from 8 to 12 days per annum.

At the end of the last financial year (March, 1919) the installation had formed part of the Chester electricity undertaking for 5½ years. Its general influence upon the financial position of the undertaking and benefit derived by the consumers of electrical energy is shown by the following allocation :—

Capital Cost, Building and Plant Installed.

Steam	£42·42	per kilowatt.
Water	£29·32	,,

B.T.U.s Generated, Sold, &c.

	B.T.U.s generated.	Used at works.	Battery and distribution.	Sold.
Steam power	10,488,519	2,180,126	1,083,400	7,224,993
Water power	9,600,615	387,338	1,201,300	8,011,977

Cost of Generating Electrical Energy.

—	Steam power.		Water power.	
	—	Pence per unit sold.	—	Pence per unit sold.
Fuel	£18,626	...	...	...
Oil, waste, water and stores	795	...	£210	...
Wages	5,208	...	1,579	...
Repairs & maintenance	2,824	...	356	...
Rents	66	...	552	...
Insurance	488	...	52	...
	£28,007	0·9308	£2,749	0·0823

Capital Charge.

—	Steam power.		Water power.	
	...	Pence per unit sold.	—	Pence per unit sold.
Interest on loans	£9,471	...	£2,714	...
Sinking fund charges	8,409	...	3,224	...
	£17,880	0·5943	£5,938	0·1779

The other charges against the revenue account are common to the undertaking as a whole, and are therefore not shown.

Obviously the foregoing figures are not strictly comparable ; they are, however, submitted to show what has actually taken place during the various changes in the last five years, and to demonstrate the value of utilising water-power in conjunction with steam electric power stations, even although the proportion of water-power be small.

How Water-power Can be Used.

Hydro-electric developments in this country are involved in the general question of ownership and use of water for private, public, industrial, domestic, fisheries, navigation, power and other purposes, and not until the laws affecting the rights to deal with water are amended in a revolutionary manner will it be possible to develop and utilise water with equity, in accordance with the natural necessities and progress of a nation. To enable the grestest use to be made of water resources a careful and systematic investigation of all the sources of water is necessary, with a view to constructing eventually works at suitable places to control the rainfall in the uplands and districts of heavy rainfall, so designed that extensions can be added from time to time and ultimately capable of retaining the waters which now run off in great quantities after much rain. The water so controlled could be released to meet all deserving demands at any period of the year. The result of such a scheme would be to establish within practical limits a more uniform flow down the rivers at all times. Whilst the control of water in this way would be of general advantage, it would also create additional possible hydro-electric developments along many rivers, which if inter-connected would aggregate a substantial supply of electricity for transmission to the nearest centre of industrial activity.

The controlling works referred to would in some cases be very extensive, and the cost of construction considerable, but as the works need only be executed to accommodate the growth in the demand for water, the final completion of the works would be when the demand reaches the maximum quantity of water available. The expenditure would, therefore, be spread over a number of years. As the construction of the necessary works would not involve the employment of a large percentage of skilled workmen, works of this character might very well be considered in connection with the organisation of employment for the thousands of prisoners serving six months and upwards in local and convict prisons.

The Government's Duty.

The control and development of virgin water resources in this way should be practicable and economical for the Government to undertake, and the expenditure recouped by levying a charge upon those who benefit by the use of controlled water. Having regard to the time taken and difficulties encountered to get the Electricity (Supply) 1919 Act, it requires an extra super optimist to predict when the obstruction besetting the development of water-power will be removed. The Board of Trade Water Resources Committee have now been deliberating on this subject for some time. The possible developments of water-power depend largely upon the completeness of the committee's investigation, the scope of their recommendation and ability to convince the Government of the benefits it is possible for the nation to derive from the undeveloped water resources of this country. Then upon the desire of the Government to legislate for the removal of obstacles which impede progress, add to the cost of development, and thereby depreciate the utility of the natural resources.

Assuming that in the near future it will be possible to procure the use of water resources expeditiously, and on more reasonable terms than in the past it should not be long before works are commenced for the development of water-power capable of generating the equivalent to 500,000,000 Board of Trade units of electricity per annum.

Experiments on Train Resistance.

Bulletin 110 of the University of Illinois contains a report of some experiments on train resistance carried out by the experimental station of the university in co-operation with the Illinois Central Railway. Tests were made to measure the resistance of passenger trains in service up to speeds of 70 miles per hour. The main results are embodied in a set of curves. The peculiarity brought out by the experiments is that the resistance is not a function of the speed alone, but a function of the speed and the car weight. The inference from the experiments is that, other things being equal, the heavier the car the less the resistance.

Experiments on train resistance on British railways have been made by Sir John Aspinall. In these experiments it was found that the train resistance is a function of the speed and the length of the train. Probably if the Illinois experiments could be re-examined in terms of the length of the train, the Aspinall formula might be found to fit the data obtained, because increase in car weight generally means increase in length of train ; one is the function of the other.

Dynamo Output Formulae.

By J. K. CATTERSON-SMITH.

The writer finds that the D^2l expression relating to the size and output of a dynamo may be simplified and, for those who are studying the subject for the first time, presented in a form which throws rather more light on the factors which govern the output of an armature. It is common experience that the introduction of the "specific electric loading" as the "ampere conductors per centimetre of circumference" to a large extent obscures these factors, and in the writer's opinion it is better omitted as being of little use except to experienced designers, and, moreover, likely to lead the inexperienced into missing essential points.

The product of the current density, ratio of slot-width to slot-pitch, slot-depth and slot space-factor, is of course, the ampere conductors per centimetre, and may therefore be incorporated in the expression for the output-coefficient which, it is believed will then appeal to many as having decided advantages over the expression as given in most text-books. The writer regrets that in two of the most interesting and valuable books* on design which have yet appeared, this point is not made very clear, and in consequence they lose a little in their value to technical colleges.

It is shown below that the output formula for a direct-current machine may thus be developed so that the specific loadings are both densities, viz., *flux-density* and *current-density*.

Armature power $= E \,.\, I$ watts, which can be expanded as follows :—

(*a*) $$E = \frac{RPM}{60} \,.\, \Phi \,.\, Z \,.\, \frac{p}{c}\, 10^{-8} \text{ volts,}$$

and $$\Phi = \frac{\pi D}{p} \,.\, \gamma \,.\, l \,.\, B_g,$$

so that $$E = B_g \,.\, \frac{\pi}{60} \,.\, \gamma \,.\, \frac{Z}{c} \,.\, 10^{-8} \times RPM \times Dl \quad . \quad . \quad . \quad (1)$$

where $\Phi =$ flux per pole in c.g.s. lines, $Z =$ number of armature conductors, $p =$ number of poles, $c =$ number of circuits in armature, $D =$ armature diameter in centimetres, $l =$ armature length in centimetres, $\gamma =$ pole-arc ÷ pole-pitch, $B_g =$ flux-density in air-gap taken at pole face.

(*b*) $$I = \Delta \,.\, a . c$$

and $$a = \text{total cross-section of armature copper} \div Z$$

$$= \pi D \,.\, r_s \,.\, t \,.\, f_c \div Z,$$

hence $$I = \Delta \,.\, \pi D \,.\, r_s \,.\, t \,.\, f_c \,.\, c \div Z \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $\Delta =$ current density in amperes per square centimetre, $a =$ cross-section of conductor in square centimetres, $r_s =$ slot-width ÷ slot-pitch, $f_c =$ space-factor of slot, $t =$ slot depth.

Combining the two equations (1) and (2) gives the dimensional expression for the output

$$E \,.\, I \,.\, \text{in } KW = \left(B_g \,.\, \Delta \,.\, \frac{\pi^2}{60} \,.\, \gamma \,.\, r_s \,.\, t \,.\, f_c \,.\, 10^{-11} \right) \times RPM \times D^2l. \qquad (3)$$

or $$KW = k \,.\, D^2l \,.\, RPM,$$

where the output-coefficient k is the product of the terms within the bracket in (3), and to each of which terms the output is proportional. It is experience as a designer which enables the correct choice of the various terms to be made, and it is hardly necessary to point out they are not independent of each other or of the size of the field system. It is convenient to remember, however, that present-day practice for machines of high rated output results in the following values for the output coefficient, where D and l are in centimetres :—

Small direct-current machines	$k = 1 \times 10^{-6}$
Medium direct-current machines	2×10^{-6}
Large direct-current machines	3×10^{-6}
Very large direct-current machines	4×10^{-6}

These values of k are, of course, only used as a guide in the preliminary lay-out of a design for a normal machine, and may have to be modified through considerations of cost and size of the magnet frame, the efficiency, voltage, regulation and commutation conditions, which together settle the final values of the various factors adopted for a successful commercial design. Limitations imposed by the above considerations will cause in a given case some departure from such common values, as

$B_g = 10{,}000$ lines per sq. centimetre depending upon size of frame,

$\Delta = 250$ to 400 amperes per sq. centimetre depending upon heating,

$\gamma = 0{\cdot}7$,

$r_s = 0{\cdot}5$, depending upon saturation required in teeth,

$t = 3$ cm. to 4 cm. depending upon size of frame.

$f_c = 0{\cdot}4$ to $0{\cdot}6$, depending upon slot insulation required.

It may be of interest to note the connection between the "ampere-conductors per centimetre" and the factors in the above expression for k, which is as follows :—

Ampere-conductors per centimetre

$$= I \,.\, Z \div \pi D \,.\, c,$$

which becomes

$$= \Delta \,.\, r_s \,.\, t \,.\, f_c$$

on substituting (2) for I.

The origin of "ampere-conductors per centimetre" was its relative importance, in the days prior to the advent of interpoles, as a criterion of a design from the point of view of the "stiffness" of the field upon which much stress was laid. Relatively powerful field systems were used, and the armature strength gauged in this way was strictly limited in working out a design.

A further point of interest is the lower values of k obtainable in all other types of machine with the exception of rotary converters, thus :—

(1) Enclosed motors, 500 volt. continuous rating, $k = 0{\cdot}5$ to $1{\cdot}0 \times 10^{-6}$, depending upon ventilation.

(2) Direct-driven turbo-dynamos, interpoles and compensation, $k = 1$ to $2{\cdot}0 \times 10^{-6}$, on account of losses, &c.

(3) Alternators, three-phase low and high speed, $k = 1{\cdot}5$ to $2{\cdot}5 \times 10^{-6}$, depending upon regulation.

(4) Induction motors, three-phase, $k = 1{\cdot}5$ to $2{\cdot}5 \times 10^{-6}$, depending upon power-factor.

(5) Rotary converters, three and six-phase, $k = 1{\cdot}0$ to $5{\cdot}0 \times 10^{-6}$ depending upon operating conditions and power-factor.

The practical application of the output formula is confined mostly to the analysis of various designs for comparative purposes and to the design of entirely new lines of machines because in commercial work almost any output can be met by one or other standard size machine. It is outside the scope of this short article to deal with the design to which belongs the proportioning of the diameter and length.

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* "The Specification and Design of Dynamo-Electric Machinery," Miles Walker. "Papers on Alternating-Current Machinery," Hawkins, Smith and Neville.

Recent Advances in the Utilisation of Water Power.*

By E. M. BERGSTROM.

The extended field given to water-power development by the application of electricity on a commercial basis, created a demand for a high-speed turbine working under low heads, and to meet this new condition American engineers turned their attention to the Francis turbine, invented in 1849, and produced a high-speed type of runner known as the "American Type." Owing to its great advantages over any other existing types, the Francis turbine has taken the lead, and revolutionised the whole aspect of water-power engineering. As an illustration of the rapid extension of the use of the Francis turbine, the manufacturing records (Table I.) of an eminent European firm of turbine-makers show the increase in output per turbine, and indicate the modern tendency of installing less units but of larger capacity.

Table I.

Period.	Jonval No.	Girard No.	Francis No.	Tangential wheels No.	Total B.H.P.	B.H.P. per Turbine.
1850–1894	904	883	7	623	179,256	74·2
1895–1899	72	99	98	232	114,818	229·1
1900–1904	8	16	464	300	390,252	495·1
1905–1909	—	—	457	336	886,582	1118·0
1910–1914	—	—	375	219	1,162,380	1956·8

This last-mentioned feature of modern hydro-electric development is evident from figures recently published by an American manufacturer, who commenced the manufacture of the Francis turbine in 1895, and since that date has completed installations with an aggregate output of 1,683,720 B.H.P. corresponding to an average output of 8,000 B.H.P. per turbine delivered. Table II. shows the most representative high-pressure turbine installations installed during the last fifteen years.

According to broad principles, the turbines are classified in two categories, namely, reaction and impulse turbines. The Francis turbine belongs to the former, and the high-pressure impulse turbine—or more familiarly known as "Pelton wheel"—belongs to the latter category. These are the only types now employed in modern water-power development.

Francis Turbines.

The fact that the standardisation of the Francis turbine was not founded on a strictly theoretical basis militated for a long time against improvements in its design and manufacture for conditions of large hydro-electric developments. Most of the leading manufacturers have now adopted the manufacture of standard runners, each series corresponding to a certain specific speed and selected to meet the conditions most frequently met with. Testing plants which have proved so valuable in the development of the design of runners are now installed in the works of most European turbine manufacturers, although in America most tests are carried out at the famous testing plant at Holyoak. Not only are standard runners accurately analysed on these testing plants, but all new special designs are subjected to test, and in the case of turbines, whose large capacities do not permit of testing, accurate geometrically similar models of small diameter are made for testing purposes, and the results represent very accurately the performance of the master runner.

The tests for the purpose of investigating the chief characteristics of runners in order to determine their performance under a varying set of conditions are carried out in specially prepared testing flumes, the turbine being generally placed in a vertical position with the runner suspended from a ball suspension bearing to reduce the mechanical losses to a minimum. A Proney brake is usually employed for recording the output, and the quantity of water measured by means of an accurate weir, by floating vane in a specially prepared channel, or by a large tank of known dimensions; the latter practice is not often adopted, but is certainly the most accurate method. These tests are distinct from, and should not be confused with, the commercial tests carried out *in situ* after the erection of a plant, in which, owing to the entrance losses in the casing and larger mechanical losses due to friction in bearings, the efficiency recorded may fall considerably below the values obtained by the same runner at the testing plant. During the tests in the testing flume the head is maintained as constant as possible, and the output and efficiency obtained at the various speeds and gate openings are plotted in diagrams with the speed as abscissa and the output and efficiencies as ordinates, when a "speed-power" and a "speed-efficiency" curve is obtained for a number of different gate-openings. The way in which these curves are obtained and used is described at length in the Paper.

Early attention was paid to increasing the unit speed of runners, the value of which became more apparent with the introduction of direct turbine-driven generators. Considerable study, both theoretical and experimental, has been devoted to this subject, and all attempts at improvements in design of runners during recent years have been in the direction of increasing the maximum value of the specific speed so as to secure a larger output under a given head and speed, or conversely to obtain the highest possible speed for a given head and capacity. The development of the high-capacity runner has had a far-reaching effect on the economical arrangement of units for low-head plants, in addition to obviating many inherent disadvantages in the arrangement of two or more runners on a common shaft, a practice which was adopted to secure a high speed in order to effect a reduction in the initial cost of directly driven generators.

Another significant fact to be recorded is the long range of gate openings for which an efficiency of over 80 per cent. is obtained. In this connection it is interesting to recall that only a few years ago Dr. Prazil, in the course of a Paper on Turbine Efficiencies, predicted that much further advance in the future could not be expected in regard to efficiencies. The average efficiency of the tests then

Table II.

No.	Plant.	Country.	Year of Installation.	Net head in feet.	Output per unit in B.H.P.	Number of units.	Speed in R.P.M.	Type.
1	The Mexican Light & Power Co., Necaxa...	Mexico	1903	1,279	8,200	6	300	4-jet vertical.
2	Brusio Hydro-Electric Plant	Switzerland	1905	1,350	3,500	12	375	Single-jet horizontal.
3	Rio de Janeiro Tramway, Light & Power Co.	Brazil	1906	950	9,000	6	300	4-jet vertical.
4	British Aluminium Co., Ltd., Kinlochleven	Great Britain	1907	900	3,300	11	300	Double-jet horizontal.
5	Tysse Hydro-Electric Plant	Norway	1907	1,260	4,800	7	375	Single-jet horizontal.
6	Rjukanfos Hydro-Electric Plant, Station I.	Norway	1908	930	14,450	10	250	4-jet twin runner horizontal.
7	Loentch Hydro-Electric Plant	Switzerland	1908	1,075	6,000	4	375	Double-jet overhanging horiz.
8	The Mexican Light & Power Co., Extension	Mexico	1909	1,279	16,000	2	300	4-jet vertical.
9	Biashina Hydro-Electric Plant	Switzerland	1909	850	11,000	3	300	4-jet vertical.
10	South California Edison Co., Kern River, Plant I.	U.S.A.	1910	865	10,750	4	250	2-jet twin runner overhanging horiz.
11	Lake Bunzen Hydro-Electric Plant, Station II.	Canada	1912	395	13,500	3	200	8-jets quadruple runner horizontal.
12	Kinugawa Hydro-Electric Plant	Japan	1912	1,050	6,000	6	375	Single-jet horizontal.
13	Rio de Janeiro Tramway, Light & Power Co. Extension	Brazil	1912	950	20,000	2	300	4-jets vertical.
14	Loentch Hydro-Electric Plant Extension	Switzerland	1913	1,150	16,000	4	300	Double-jet overhanging horiz.
15	Tata Hydro-Electric Plant, Bombay ...	India	1914	1,650	13,500	6	300	Single-jet horizontal.
16	Rjukanfos Hydro-Electric Plant, Station II.	Norway	1914	830	16,400	10	250	4-jet twin runner horizontal.
17	Aura Hydro-Electric Plant	Norway	1916	2,350	23,500	6	250	Single-jet horizontal.

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* Abstract of a Paper read before the Institution of Mechanical Engineers.

published was 85 per cent., which value has been greatly exceeded, and a general increase of 10 per cent. above efficiencies obtained about 12 years ago can now be recorded. The efficiency, in itself a valuable asset, is, however, not the all-important feature of modern turbine developments; the improvement in mechanical details and construction and simplicity in design, together with higher standard of workmanship, are all important factors which have contributed to the advances in the utilisation of water-power, by ensuring freedom from breakdowns, continuity of operation, simplicity in working and accessibility to effect repairs, all of which are of vital importance in connection with any power development.

The most notable developments in hydro-electric power plants which have taken place in recent years have been stimulated by the development of the "high capacity" runner. This latter construction has permitted the adoption of the single vertical turbine, which possesses many economic advantages over the arrangement of the multiple runner, either on vertical or horizontal shaft, and has facilitated the promotion of the large-power low-head hydro-electric undertakings which, during the last six years, have shown such a remarkable development in the United States of America.

A short description of the Mississippi power plant at Keokuk shows that in spite of its enormous size and capacity the arrangement is compact and simple, and does not possess the objectionable features inherent to the previous practice of multiple runners. The outstanding feature is the absence of any submerged bearings, and the thrust-bearing, guide-bearing, regulating gear, and in fact all auxiliary parts of the runner, are above water level, and readily accessible for inspection and necessary repairs.* The cost of maintenance is less, and the arrangement with a single suction-tube secures the highest possible efficiency, together with simpler and cheaper construction of the foundations.

The turbines for the Cedar Rapids Station on the St. Lawrence River are the largest ever contemplated, and show a few interesting improvements over the early Mississippi type. The most notable of these improvements is in the design of the foundation-ring, or the so-called "speed-ring," which, instead of being cast in two rings, one upper and one lower, and connected by means of stay-bolts, is now cast with vanes connecting the two rings and given fin-shaped section, which offers less hydraulic resistance and from a mechanical point of view is preferable as being a solid connection between two rings. Another point which is worth mentioning is the practice of arranging the combined thrust-bearing on the top of the generator instead of below floor level, the advantage being greater accessibility. The Kingsbury bearing has been employed throughout this plant, but a novel feature has been introduced, the bearing being combined with a roller-bearing of reduced dimensions. Normally the roller-bearing is not in action, being set with a slight clearance, but in case of weeping action of the Kingsbury bearing taking place, it would support the load for a time, and prevent any serious breakdown of the plant.

A unique installation of the medium-pressure type turbine is the Porjus Power Station, Sweden. This plant is situated underground, but the turbines are enclosed in steel casings and placed at the bottom of the intake-shafts about 160 ft. below ground level. The vertical shafts are cut through solid rock and provided with liners of steel pipes with an internal diameter of 11 ft. 6 in., and with flanged connection to the turbine-casing. There are five units with an average capacity of 12,500 H.P. each under a net fall of 163 ft., running at 225 revs. per min. The turbines are of the double type with two runners, discharging into the common suction-casing. The power-house is also blasted out of solid rock, and is 36 ft. wide and 310 ft. long, communicating with the turbine chambers through the short tunnels which accommodate the shaft extension connecting turbines and alternators. The roof is supported on a strong concrete arch, and by the provision of false walls and roofs leaving a space between the rock and the walls through which warm exhaust air from the generator is allowed to pass, all damp is prevented from penetrating into the power-house. The generators have a normal output of 11,000 k.v.a. at 10,000 to 11,000 volts. The necessary switchgear and transformers are also in this case placed in a separate building on ground level, a shaft providing communication between this building and the power-house below, through which the heavy parts of the machinery can be lowered, in addition to which, there is lift accommodation both for passengers and goods. The line voltage is 80,000, the power being utilized for railway traction and for mining purposes.

HIGH-PRESSURE FRANCIS TURBINES.

Much attention has of late been focussed on the development of low and medium Francis turbines, but nevertheless the high-pressure Francis turbine has shared in the remarkable and rapid development and improvement in design of the hydraulic turbine. The most notable feature is its adoption for a very much higher head than ever contemplated until a few years ago, so that, under certain conditions, it rivals the Pelton Wheel, which, until recently, was the only accepted type of turbine to be adopted for high heads. The reason for this is the modern tendency of larger capacity per unit, coupled with maximum permissible speed to reduce the cost of the electric generators. As a result, the design of the Francis turbine has been modified and improved to answer the additional requirements of water turbines working under high pressure, and has now been employed under heads of approximately 745 ft.

SPEED REGULATION.

The development of the design and construction of governors has naturally been closely bound up with the general advances in the design of Francis turbines. In fact, it may be stated without exaggeration that the progress in the application of water-turbines is to a great extent due to the satisfactory solution of the governor problem as the provision of a quick acting and reliable speed-controlling device forms one of the most important features of hydro-electric development. The old type of mechanical governor proved totally inadequate for the needs of efficient speed-control in connection with hydraulically-driven generators. As a consequence the hydraulic type of governor was evolved, which in the first place was actuated by the water pressure, but later, however, was substituted by oil pressure in order to eliminate several bad features of the water-pressure governor, that is, sticking due to gritty water, and liability to corrosion of the various mechanical parts. The automatic oil-pressure type of governor has been steadily improved, and has now reached a high state of perfection, possessing all the qualities required by modern practice for effective and reliable speed-control.

For large turbine units the servo-motor is built together with the turbine, and in the case of several units, are all supplied from a central oil-supply system. In the case of enclosed turbines supplied through pipe-lines, the closing time of the governor and guide-vanes respectively must be adjusted correspondingly longer than in the case of open-type turbines in order to avoid dangerous pressure rises in the pipe-line, owing to the change of momentum of the flowing mass of water, in addition to providing a heavy fly-wheel to keep the speed variation within permissible limits. This arrangement is only possible where the pipe-line is comparatively short, and cannot be adopted for high-pressure turbines where the hydraulic conditions imposed by high head and long pipe-lines render the governing problem far more difficult. In such cases the governor is operated in conjunction with a pressure-regulator or relief-valve, in such a manner that when the governor closes the guide-vanes of the turbine the relief-valve opens, discharging the water into the tail-race, so that the same amount of water is flowing through the pipe-line, thus avoiding any change in the momentum, and consequently no pressure rise can occur.

In this type of pressure-regulator the governor furnishes the necessary power to operate the valve. This type of valve could not be used with advantage in many plants, as a very large capacity governor would be required to operate the valve. The modern type of pressure-regulator for Francis turbines has therefore been designed in such a manner that the governor only operates a small relay valve, the water pressure in the pipe-line being utilized to operate the valve, and thus obviate the additional power being imposed on the governor.

SURGE TANKS.

A further point which must be subject to particular consideration is the fact that in many medium-pressure plants the pipe-line is often of considerable length as compared with the total head, so that in case of a sudden demand for an increase of flow following a sudden increase of the load on the turbine, the water in the pipe-line cannot accelerate at such rate as required by good governing. It is apparent that the pressure-regulator cannot, in this respect, be of any assistance, and under these conditions a standpipe or surge-tank must be provided. In the event of a sudden throwing off of the load on the turbine, the water would rise in this tank and absorb the energy given out by the flowing water column when changing its momentum during the retardation of the flow and corresponding to the new load conditions. On the other hand, in the event of a sudden demand for more power, the stored water in the surge-tank would instantaneously supply the additional quantity of water required until the water column in the upper portion of the pipe-line has had time to accelerate, and consequently the level in the tank would be lowered. The area of the tank must be so dimensioned that the amplitudes of the water-waves or oscillations are as small as possible and steadily diminish until the quiescent water-level is reached, in order not to influence adversely the conditions for stable governing.

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* H. Birchard Taylor, "Vertical Shaft Single-Runner Turbines as Applied to Low Heads."—"General Electric Review," June, 1913.

Table III.—*Available Water-Power in the Principal Countries of Europe and America.*

Country.	B.H.P. available.	B.H.P. developed.		Area in sq. miles.	Population.	B.H.P. available per sq. mile.	B.H.P. developed per sq. mile.	B.H.P. per capital.	
		In B.H.P.	In per cent.					Available.	Developed.
U.S.A.	28,400,000	7,000,000	24·9	2,973,890	98,783,300	9·4	2·35	0·28	0·071
Canada A*	18,803,000	1,735,000	9·2	2,000,000	8,033,500	9·4	0·87	2·34	0·216
Canada B.	8,094,000	1,725,000	21·3	927,800	8,000,000	8·7	1·86	1·01	0·216
Austria-Hungary	6,460,000	566,000	8·8	261,260	51,173,000	24·8	2·17	0·13	0·011
France	5,587,000	1,100,000	11·6	207,500	39,601,500	26·8	3·14	0·14	0·016
Norway	5,500,000	1,120,000	20·4	124,130	2,391,780	44·3	9·62	2·30	0·468
Spain	5,000,000	440,000	8·8	190,401	19,588,700	26·3	2·31	0·26	0·022
Sweden	4,500,000	704,000	15·6	172,960	5,522,400	26·0	4·08	0·81	0·127
Italy	4,000,000	976,000	24·4	91,400	28,601,600	43·8	10·7	0·14	0·034
Switzerland	2,000,000	511,000	25·5	15,976	3,781,500	125·2	32·0	0·53	0·135
Germany	1,425,000	618,100	43·4	208,800	64,926,000	6·8	2·96	0·02	0·010
Great Britain	963,000	80,000	8·3	88,729	40,831,400	10·9	0·91	0·20	0·002

Estimate 1915. * A includes Yukon and Northern Area improbable of immediate development.

Pelton Wheels.

The chief characteristic of the impulse wheel is the long range of load during which the efficiency is constant. The same tendency to adopt a uniform design is also noticeable in respect of the nozzle where the various designs of rectangular nozzle with movable lip have been discarded in favour of the circular nozzle with concentric pear-shaped spear or interceptor movable in axial direction for regulating the quantity of water which is employed in modern Pelton wheel design. The most important improvement, however, is in respect of the system of regulation, which, as in the case of the Francis turbine, had to be adapted for the new conditions of electrical transmission, and at the same time conform to the increased demand for accurate and reliable automatic governing. Three distinct systems of automatic governing are now employed, namely: (*a*) bypass valve regulation; (*b*) regulation with deflecting nozzle; (*c*) combined spear and deflector regulation. The object aimed at in each of these methods of automatic control is to obtain an instantaneous regulation of the quantity of water in response to any load changes, at the same time ensuring a slow and gradual retardation of the flow in the pipe-line to obviate any dangerous increase in pressure.

Pipe Lines.

The design and construction of the pipe-line forms one of the most important sections in connection with a hydro-electric plant. The material used in the construction of low-pressure pipe-lines is either concrete, riveted steel, or wood. The concrete pipe line has certain points of merit as regards initial cost and durability, and has an undoubted field of usefulness. On the other hand, the lack of flexibility and high co-efficient of expansion renders it necessary to make provision to prevent cracks due to uneven settlement where the soil is of a loose nature, and also suitable expansion joints, which is often a difficult matter. Wood stave pipes are utilised to a great extent for pressures up to about 175 ft., both in America and Canada. For use in connection with water-power developments the pipe is made "continuous," the rough lumber being made into staves of correct shape and angles, and joined together on site by means of wooden or metal tongues and breaking joints between adjacent staves so as to form a continuous length. The finished pipe is wound round with iron hoops and secured by adjustable clamps of malleable iron, through which the threaded ends of the rings pass and are tightened by means of washers and nuts. One of the chief characteristics of the wooden stave pipe-line is its durability and low cost, together with a low coefficient of friction, and is therefore of particular advantage for the construction of the upper portion of pipe-lines where suitable wood can be procured.

The two types of steel pipes, riveted or welded, are used in connection with hydro-electric plants, the former for low and medium pressures, and the latter exclusively for high-pressure plants. For long pipe-lines under low heads, the riveted pipe has been superseded either by concrete or wood, as for large diameter, the riveted pipe must be made sufficiently thick to retain its circular shape, and in addition take all the bending stresses caused by the weight of the water to allow as great a distance as possible between the supports, and consequently the cost is very often prohibitive as compared with a conduit made of either of the first-mentioned materials.

The welded steel pipe-lines signify the most important developments in recent years as a result of the progressive utilisation of high heads which necessitated a closer study of the pipe-line construction than had hitherto been the case. The welded pipes are made by the water-gas process, the plates being bent to shape and the overlapping edges heated by means of water-gas and welded together under high speed mechanically driven hammers, which method produces a weld of a strength of approximately 95-97 per cent. of the strength of the full plate. After welding, the pipes are annealed to remove all internal stresses.

Conclusions.

The outstanding features in the development of the utilisation of water-power can be summarised as follows:—

1. The exclusive use of two types of turbines only, namely, Francis re-action turbines for low and medium heads, and Pelton impulse wheels for high heads.
2. The extension of the use of Francis turbines under heads approaching 800 ft., and Pelton wheels in single stage up to 5,500 ft.
3. The exclusive adoption of balanced wicket-gates for regulation of Francis turbines and the circular nozzle with combined deflector and needle regulation for Pelton wheels.
4. The standardisation of turbine runners and increased specific speed permitting the use of single vertical units of large output under low heads.
5. The general increase of output per unit, the maximum output at present being 31,200 b.h.p.
6. The general increase of the overall efficiency of about 6 to 10 per cent.
7. The exclusive use of oil-pressure governors.
8. The efficient regulation (by means of differential surge-tanks) of turbines using long pipe-lines.
9. The employment of large diameter pipe-lines under high heads resulting in an appreciable reduction of the initial cost of development.

These developments, coupled with the improved construction of impounding dams in addition to multifarious improvements in details to ensure effective safeguards and reliability in operation, constitute an enormous advance from a purely technical point of view. According to Prof. Gibson's estimate, the total amount of water-power available in the world exceeds 200 million horse-power, and in Table III. is set out the available water-powers capable of economic development in the principal countries in Europe and America, together with the amount already developed, as published by the Water power Branch Ministry of Interior, Ottawa, which cannot fail to reveal the enormous scope for further developments of the world's water-power resources.

Measurement in Steel Works.

The "Hardware Trade Journal" gives a description of the pyrometric recording station which is installed close to a group of treatment furnaces at the Elswick works of Sir W. G. Armstrong, Whitworth & Company, and of the pyrometric and testing laboratories which have been erected in duplicate at the Elswick and Openshaw works of the same Company. The work undertaken in the chemical laboratories comprises the analysis of steels, ferro-alloys, non-ferrous metals, fuels, refractory materials, lubricants, paints, gas, explosives and all general commercial products. The numerous furnaces of which both the electrical and gas types are installed are controlled by pyrometers which are constantly being calibrated from the pyrometric laboratory. The laboratories are fitted with tensile and bending testing machines, impact, shock, Brinell, and other machines for examining the materials employed in motor-car, aeroplane, locomotive and general engineering construction. A special section of the works is set aside where repeat experiments are carried out on a large scale under identical works conditions. The laboratory staff have the duty of collaborating with the works to see that operations and processes are effected on scientific lines. Close observation is kept of possible sources of waste, including especially the reclaiming of steel and metal waste during manufacture and the utilisation of metallic oxides recovered from flues.

Present-day Radiography.

By Major G. W. C. KAYE, O.B.E., M.A., D.Sc.

The greatest stimulus in the history of mankind was given to surgery and medicine during the war. Each gained new powers due in great part to the increasing utilisation of physical agents and physical methods. Through the agency of the X-rays, electricity, heat and light radiations, together with massages, many thousands of wounded soldiers have been saved from a life of hopeless misery and humiliation. The X-ray has now become as indispensable to the surgeon as the dressing or the splint, and it is an essential adjunct in prescribing and directing as well as in avoiding operations. The X-ray detection of embedded bullet and shell fragments in any part of the body became so certain in the war as to be commonplace.

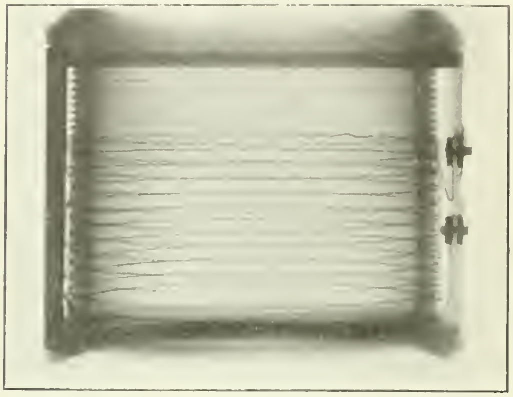

Fig. 1. Radiograph of Electrically-heated Earthenware Coffee-Pot. (Sunic Research Laboratories.)

Stereoscopic radiography and flash radiography, using exposures of 1/100 second or less, have attained a wonderful pitch of excellence. X-ray technique has, in fact, improved so vastly as to give the diagnostic methods of physician and surgeon a facility and precision which was never dreamt of at one time. Furthermore, a new branch of radiography has developed within the last year or two, in the application of X-rays to the study of materials and structures. This new science of industrial radiography has a promising future before it.

The Röntgen Society Exhibition.

An unusually instructive demonstration of the progress of radiography was provided by the collection of radiographs by members of the Röntgen Society recently exhibited in the rooms of the Royal Photographic Society. The two hundred or so radiographs served to illustrate the development of the art since the discovery of the X-rays some 24 years ago. On two evenings during the four weeks' run of the exhibition, the members of the Royal Photographic and Röntgen Societies met on subjects of common interest. On the first evening Dr. G. H. Rodman gave a popular lecture on the X-rays, and on the second evening a discussion was opened by the author on radiology and radiometallography.

The feature of Dr. Rodman's discourse was the marvellously beautiful collection of radiographs shown on the screen. Some of the shell radiographs taken by Dr. Rodman must have tempted many a photographer in the audience to consider whether he should change his wave-length and go in for radiography in future. For, as is now well known, it is only the fact of X-rays possessing wave lengths some 10,000 times shorter than those of light, that gives the former their uncanny property of penetrating substances opaque to light. With X-rays there is no distinction as in light between transparent and opaque bodies; there are only degrees of transparency. The transparency of a body depends both on its thickness and on the atomic weight of the atoms of which it is built up. A lead atom, for example, is much less transparent than one of aluminium. The transparency is not affected by physical or chemical states; it is the same whether the substance is hot or cold, or whether the atom is free or combined. The higher the voltage on the X-ray bulb, the shorter the wave length and the "harder" or more penetrating are the X-rays. X-ray photography may be likened to shadow photography, and here we would plead for some unification of terms. Just as a photographer talks of a photograph, we would suggest a radiographer should refer to a radiograph in preference to a radiogram, skiagraph, skiagram or (in America) Röntgenogram.

The Coolidge Tube.

So far as the X ray tube is concerned, the Coolidge tube is by far the biggest step in progress. Its own development has been chiefly in the direction of smallness. The radiator tube, which keeps its target cool by means of external cooling fins, possesses the valuable property of self-rectification, so that the tube can be joined direct to an interrupterless transformer. A recent development both in America and this country has been the enclosing of both X-ray tube and the exciting transformer in the same aluminium tank full of oil. All the high-tension wires are thus enclosed, and the arrangement is foolproof on this score.

Coolidge's latest type of tube, designed especially for portable apparatus, is made of very thick lead glass with a thin window of ordinary glass. The walls are about ¼ in. thick, the overall diameter of the tube being only 2½ in. Thus a large measure of protection is provided for the operator by the tube itself. In 1915 Coolidge, by the use of water-cooled targets, carried out some remarkable experiments on power-input. Some of the tubes were run continuously for two or three days, passing 200 milliamperes at 70,000 volts. The power absorbed was thus 14 kw., or 18 h.p.

The question of the relative merits of the induction coil and the transformer is at present the subject of great controversy. A combined meeting of the Institution of Electrical Engineers, the Röntgen Society and the Electrotherapeutic Section of the Royal Society of Medicine will attempt to thrash out the question on February 26th. X-rays have been detected through as much as 5 mm. of lead, and for adequate protection of the operator 3 mm. of lead is advisable. Lead glass or lead rubber is from 15 to 25 per cent. as efficient as the same thickness of lead.

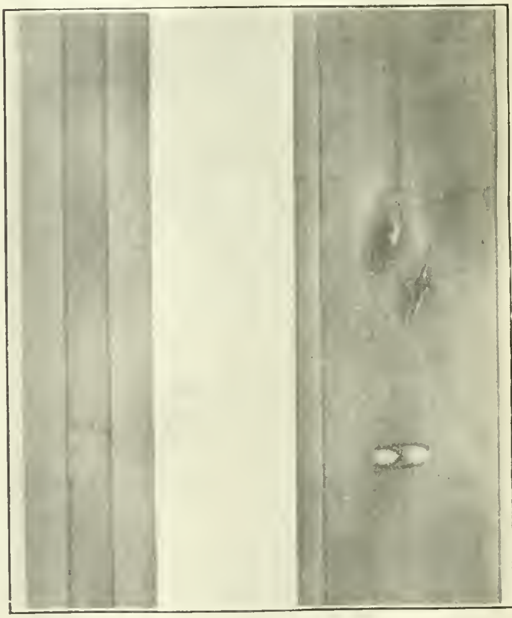

Fig. 2. Radiograph of Laminated Aeroplane Spar, Showing Concealed Knots and Grub-Hole in Middle Lamina. (Knox and Kaye.)

Radiometallography.

With reference to the new science of radiometallography, the great advantage of the method is, of course, that we can spy out the interior of an opaque body without injuring it in any way. So far, the present practicable depths which can be investigated are about 3 in. of steel, about 6 in. of aluminium and 12 in. or more of wood. The method is surprisingly sensitive, for example, different qualities of a metal possessing different densities display different intensities in a radiograph—*e.g.*, a wrought rivet in a casting of the same metal shows up as a darker image. Equal thicknesses of carbon, nickel and tungsten steels differ markedly in transparency. Porous regions in metals show up as light patches. In alloys the uneven distribution of any component yields a "patchy" radiograph.

Flaws, blowholes and other defects in castings, forgings and welds (either electric or acetylene) show clearly. In a bad weld the edges of the original plates can be seen, but they entirely disappear if the weld is satisfactory. Blisters and blowholes show up as light spots, their presence affording a guide as to whether the heat has been excessive. X-ray examination will often diagnose hidden corrosion, defective soldering or brazing, the substitution of one metal for another, concealed riveting, stopping or pinning to cover defects and so on. Many other uses will doubtless occur to the electrical engineer. The method has its limitations—for example, hair cracks in castings which usually follow a tortuous path, are very fine and cannot be detected. Again, if the body has a complicated shape, and consequently casts a complicated shadow, its interpretation may be impossible.

X-rays and Heavy Engineering.

So at present the method is in practice confined to relatively "straightforward" jobs, in which the thickness of metal does not exceed the above figures. But in the case of heavy engineering much greater thicknesses are involved, and if progress is to be made, means will have to be found so that exposures may not be intolerably long.

As far as power goes, the electrical engineer, if we can only interest him, can give the radiologist the electrical power he needs, at any rate, if the voltages are not excessively high. The stumbling block is the X-ray tube. We want a super-Coolidge tube as much superior to the ordinary Coolidge as the Coolidge is to the ordinary gas tube. The great difficulty is, all X-ray tubes are so inefficient, 1 part in 1,000 is an average figure, the rest being converted into heat at the target. Consequently we have to pump much excess energy into the tube and overcome the heat difficulties as best we may. Glass envelopes will not stand up to excessive energy input, and we may have to turn to silica or metal bulbs.

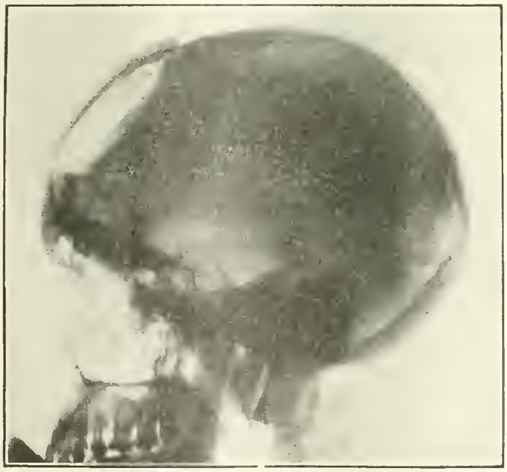

Fig. 3.—Radiograph of Fractured Skull.

It cannot be denied that, had it not been for the Coolidge tube, radiometallography could never have been considered as a commercial proposition, for the penetrating power of the hardest rays emitted by an X-ray bulb depends directly on the voltage applied to the tube, and we can apply much more voltage to a Coolidge than to a gas tube. Now it can be shown that the thickness of metal penetrable by X-rays varies as the cube of the voltage—*i.e.*, if we double the thickness, the voltage has to be multiplied by 8, to keep the exposure the same, assuming our means of registering the rays are equally good. Now, the ordinary Coolidge tube will take no more than 200,000 volts, preferably less. This can be boosted up to 300,000 by lengthening the tube and completely immersing it in oil. But the increase in penetrating power in stepping from 200,000 to 300,000 volts is not large, and moreover the dangers arising from such enormous voltages cannot be denied

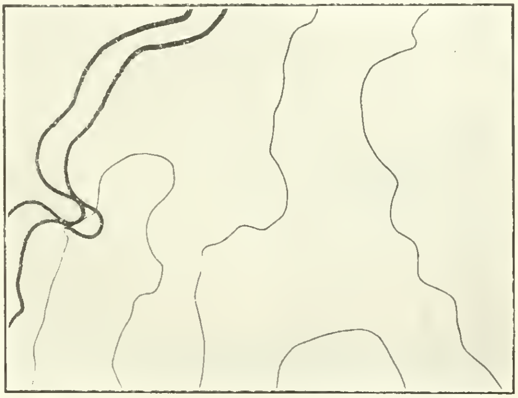

Fig. 4.—Radiograph illustrating Method of Searching for Break in Heating Element, Sewn in Lining of Aeroplane Pilot's Leather Waistcoat. (Sunic Research Laboratories.)

The case would seem to be on all fours with wireless telegraphy, where the power at transmitting stations ceased to climb up when the thermionic detector arrived. We want an equally sensitive detector for the X-rays, for that way progress lies. As regards screens, there is room for great improvement, for at the present time we cannot screen more than 2 mm. or 3 mm. of steel. As to photography, there is room here also for improvement. So far progress has been in several directions. One consists in thickening the emulsion or richly loading it either with more silver or with heavier metals—the benefit is appreciable though not markedly so, and the difficulties of development are increased.

The intensifying screen has, of course, been responsible for great increases in sensitiveness—twenty-fold, in some instances. Some good illustrations were shown in the exhibition referred to. Apropos of intensifying screens, most British screens, for example, the Sunic, are very fast, but impair the detail slightly in certain classes of work. Some of the new American screens are wonderfully free from grain, but only at the sacrifice of speed. Incidentally the importance of the closest contact between the screen and the emulsion is very great for high class work. The flexible celluloid backing of some American films helps to get good contact One of the biggest advances in X-ray photography has proved to be the duplitised film—*i.e.*, a film coated with emulsion on both sides of the celluloid—an idea not as American as is generally imagined. But we want something which will take matters into another stage of sensitiveness altogether. If such plates arrive, and radiometallography may provide the necessary stimulus for plate makers to "get busy," medical radiologists stand to reap the benefit. Perhaps, however, photography may not be the key. X-rays exert certain chemical effects—can we find an infinitely sensitive chemical test; the X-rays reduce the electrical resistance of selenium—can we get over the fatiguing effect and develop this into a sufficiently delicate method; the X-rays ionise a gas—can we call in the thermionic valve; it should be a relatively easy matter to arrange.

Aircraft Radiography.

During the war Dr. Knox and the author, on behalf of the Aeronautical Inspection Department, developed a method of examining the wooden parts of aeroplanes by X-rays, both in regard to material and construction. The method (of which some examples were on view in the exhibition) was not applied so much to parts made of solid wood as to those constructed on the laminated or "box" principle. This method of construction—which was introduced at a time when the country's supplies of high-grade aeronautical timber were running short—enables much smaller timber to be used, but adds very greatly to the difficulties of inspection. Owing to the type of construction, together with the fact that many such wood parts are usually wrapped in fabric, it has been possible for certain defects to avoid detection except by destructive tests.

But the inspector now receives a powerful ally in the X-rays, which reveal with astonishing clearness hidden faults such as knots, grub holes, bad gluing and poor workmanship in the internal structure. As all woods are particularly transparent to X-rays, a fluorescent screen can be used for much of this work.

Other possibilities may be foreseen of the practical applications of X-rays to the examination of timber generally. It may even prove expedient to radiograph valuable growing trees to search for defects. Further, X-rays are capable of revealing "figure" arising from contortions of the fibre, a feature of high commercial importance.

The presence of severe internal shakes, filled with mineral deposits (like the phosphates in teak) or of foreign bodies, is clearly revealed by the rays. Accidents to both sawmill plant and workmen have frequently been caused by stones, old axes, nails, staples, &c., which, left in a fork of a tree or driven into the butt, have been subsequently overgrown with sound wood.

Careful examination by the X-rays of hardwood destined for aeroplane propellers, &c., might serve to detect incipient cracks indicative of internal residual stresses produced by improper methods of kiln drying. Such stresses may lead to subsequent warping or even actual tearing of the glue joints.

RADIOGRAPHY OF OIL PAINTINGS.

Probably the most novel radiographs in the exhibition were those by Dr. L. G. Heilbron, of Amsterdam, of certain Dutch oil paintings of date about 1500. Suspected of having been altered by a subsequent artist, the pictures when radiographed clearly revealed this to be the case. In one picture an infant in the arms of a Madonna had been painted out, and in another a female figure — a sometime donor of the picture — had been superimposed on that of a monk.

The medical side of radiography was well to the fore at the exhibition, but space forbids a full discussion. Dr. Knox showed a series of masterly prints, including a flash photograph of a hand which, for contrast, was mounted alongside one of Mr. Campbell Swinton's, taken in January, 1896, with 2,000 times the exposure! Another radiograph of interest was the hand of a mummy. A very large print, some 8 ft. by 4 ft., was that of a complete human skeleton. Dr. Thurstan Holland and others showed brilliant work in chest and abdominal radiography. Beclere was responsible for some fine examples of a method of obtaining radiographed finger-prints. Among others we noticed exhibits of great interest on radiometallography from Pilon and the Sunic Research Laboratories.

In conclusion, congratulations are due to the Röntgen Society, which, now recognised as one of the most progressive of the London societies, deserves commendation for the way it continues to secure the co-operation of its physical, electrical engineering and medical members in a common effort for the future of radiology

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Transformers for Electric Furnaces.*

By J. L. THOMPSON, M.Sc.

(Concluded from p. 117.)

MECHANICAL STRESSES.

Mechanical stresses take place frequently during the melting period and are brought to bear on the coils and leads. The operating power-factor during this period of a steel furnace (conduction type) is about 0·8. The above figure is rarely exceeded until the bath is completely molten.

When the furnace bath is molten and the arcs become steady, the power-factor rises to 0·9 or 0·92. Taking the melting period with a power-factor of 0·8, the reactance voltage in the circuit is consequently 60 per cent., so that if the arc should be short-circuited the maximum current would be 1·6 times full load. When molten and at a power-factor of 0·9, the reactance voltage in the circuit is 43·5 per cent., and permits of a maximum short-circuit current of 2·3 times normal.

A 2,000 k.v.a. 25-period single-phase shell-type transformer, having a reactance of 7 per cent., will, if short-circuited directly across its secondary leads, allow a current of approximately 14·3 times its full-load current to flow provided the supply voltage is maintained. This current brings a mechanical stress to bear on the coils in an axial direction of approximately 60 tons.

If the transformer is supplying a furnace and during the melting period (power-factor 0·8) is short-circuited by the electrode coming into direct contact with the bath, the short-circuit current that will flow will be 1·6 times full load, since the reactance in circuit is 60 per cent., *i.e.*, 7 per cent. in the transformer + 53 per cent. in the furnace lay-out.

The mechanical stress due to this current is approximately 0·3 ton on the coils in an axial direction.

If the short-circuit occurs during the molten period, *i.e.*, power-factor 0·9, the short-circuit current is 2·3 times full load, for the reactance in circuit is now approximately 43·5 per cent., *i.e.*, 7 per cent. in the transformer and 36·5 per cent. in the furnace and lay-out. This current brings a mechanical stress of approximately 0·8 ton on to the coils in an axial direction.

Thus during normal operation, furnace transformers are not subjected to heavy mechanical stresses by the short-circuiting of electrodes. Heavy stresses do occur if the transformer low-pressure terminals, or if the primary windings between tappings become short-circuited.

FURNACE LAY-OUT.

The satisfactory operation of electric furnaces depends also on the relative positions of transformers and furnace and the heavy current connections between them. The effects of a bad lay-out are chiefly—

Low operating power-factors, hence inefficient working and a possible loss of useful working voltage.

Heating up of leads, clamps and cables.

Unbalancing of voltages on the furnace and unbalanced load currents and phase relation on the supply side of the transformers. This excess value or inequality of inductance causes heavy or unequal voltage drops in the leads—a trouble which grows with increase of current.

In order to reduce the possibility of a heavy choking effect and unbalanced voltages, the following suggestions will be helpful:—

1. Transformers should be placed as near to the furnace as possible, so that heavy low-pressure leads may be of minimum length.

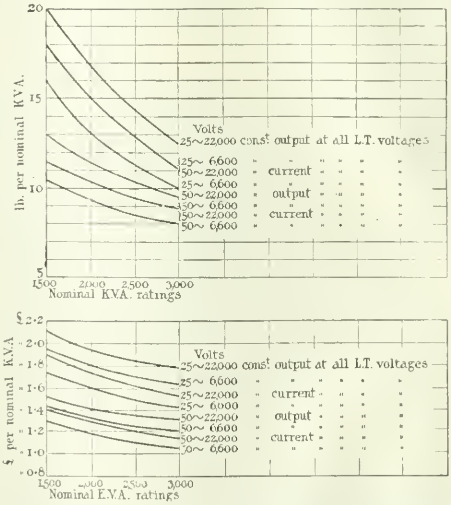

FIG. 5.—CURVES OF APPROXIMATE WEIGHT AND PRICE PER NOMINAL KILOVOLT-AMPERE RATED OUTPUT FOR SINGLE-PHASE OIL-INSULATED WATER-COOLED AND OIL-INSULATED FORCE-COOLED FURNACE TRANSFORMERS WITH LOW-PRESSURE RANGE OF 1 TO 1·31.

2. Low-pressure leads of the various phases should be symmetrically placed with respect to transformers and furnace.

3. The area between positive and negative low-pressure leads should be as small as possible, and also that between phases, so that inductance may be a minimum.

4. Low-pressure leads for heavy currents (above 5,000 amperes) should be in multiple and interleaved from the transformer to a

point as near the furnace as possible. This will keep the inductance low and make that of each lead approximately the same, thus ensuring that each parallel lead takes its proper share of the load.

5. Heavy current leads should not be run near any heavy magnetic structure such as girders or supporting columns, unless both the positive and negative leads are run together and interleaved.

6. No magnetic material should form a closed circuit around any positive or negative conductor, or heavy currents will be induced in that circuit. The positive and negative conductors interleaved may be run through a magnetic circuit. Clamps for heavy current leads should be of non-magnetic material.

If these are followed, little trouble will be experienced in connection with furnace lay-outs up to fairly large sizes. In future heavier currents will have to be dealt with than in the past, and a limit may be reached owing to the greater latitude required as regards loop area for the accommodation of the leads. In conducting hearth furnaces, the height of the loop becomes excessive and a large enclosed area results, leading to a low power-factor, low electrode voltage and inefficient working. In some cases little additional energy is obtained on the furnace due to an increase in load.

Cost and Weight.

The cost and weight of furnace transformers are dependent on the maximum low-pressure current and the voltage variation required, apart from the variables of voltage and frequency. In general, the furnace transformer kilovolt ampere rating is a figure much below that for a power transformer of the same weight.

For instance, take a 2,000 k.v.a. 25-period 6,000/65 ; 75 ; 85-volt transformer with full output at each tapping ; this would be equivalent in weight to a 2,620 k.v.a. power transformer. If the low-pressure current is constant at each low-pressure voltage, then the equivalent power transformer for the same weight would be 2,310 k.v.a.

Approximate prices and weights are given in the curves, Fig. 5. for transformers whose voltage variation is obtained by means of tappings. For furnace transformers complete with boosters or regulating transformers, the prices would have to be increased 10 to 15 per cent.

DISCUSSION.

Mr. H. M. Sayers said a transformer for furnace purposes had to be a caricature of ordinary transformer design on account of the abnormal conditions it had to meet. In furnace transformer design the designer ought to be the designer of the whole electric circuit from the transformer to the furnace electrodes, and he should know in advance the maximum reactance that would be introduced and make allowance for it in the terminal voltage on the low tension side. He gathered from the Paper that tappings on the primary were favoured, but that the author was not very well satisfied with that condition of things. There might, however, be cases where that method could be adopted without much risk. If the transformer were fed from a star-connected three-phase system with the star-point earthed, tappings at the neutral end of the primary might not entail a great amount of risk. The rational method surely was the one mentioned by the author of using a booster externally to the transformer and regulating on that. That had the advantage of keeping up the power factor. Would it not be better to split up the flux paths and have a number of them in parallel ? The number of low tension turns could then be integral and the lead lengths and other dimensions could be exactly alike. He thought the ratio of active to inactive copper on the low tension side could also be made higher if the primary leads were exactly the same length. Splitting up the flux paths would increase the amount of iron required, and perhaps also the amount of copper, but it would make it easier to support the low tension leads against short circuit. It would also improve the circulation of oil or other cooling media. It would involve a larger external case, and that meant that the whole transformer would get rid of its heat at a lower temperature. The author had a predilection for the shell type transformer. That was understandable from the designer's and manufacturer's point of view, but from the operating engineer's point of view the core type was infinitely superior.

Mr. A. M. Taylor said the author seemed to be of opinion (and his figures seemed to justify it) that there was so much reactance in the leads that one could not get a very severe short-circuit. The discussion on Westinghouse transformers about nine months ago gave the impression that there would be very severe stresses on the windings. The last speaker thought that a booster might improve the power factor. As a matter of fact, the power factor conditions seemed much the same in the static booster and the main transformer, but an advantage of the booster was that one could either put the high tension winding one way in reference to the mains or reverse it or short-circuit it. Had it occurred to the author that if the high tension winding of the booster could be twisted round through 120° on to the next phase of the supply it would bring the power factor up to unity on the main supply at the expense of the current in the high tension winding of the buses ? If one had a split feeder and put all those high tension windings in the booster to the split feeder, ran that back to the power station and put the whole on to a generator to give the wattless components the main supply would then be working, so far as the furnace was concerned, at an average of unity power factor, and disturbances of the pressures of consumers' supplies would be avoided. During the last six months he had found it possible to superpose a 25 ∾ system on a 50 ∾ system and have the systems distinct so that the frequency or voltage of either could be varied without interferring with the other system. All the furnace transformers could be put on the superposed system and the tremendous fluctuations on the lighting and other consumers' systems would be avoided. Could the author say whether the furnaces were equally suitable for lower frequency, as many towns had only 25 ∾ ? If not, what he had mentioned might be a way out of the difficulty. He suspected that the author did not like Scott-connected transformers. Would he explain why ?

Mr. S. E. Fedden said the high tension tappings had always been a source of failure. The author mentioned a furnace of 15 to 30 tons capacity supplied from a transformer of 8,000 k.v.a. That furnace would have to be oblong or oval, and he would have preferred to have had for it four sets of 2,000 k.v.a. transformers, a set to each pair of electrodes if possible. Dividing the transformers up and getting them close to the electrodes reduced the self-induction of the leads and gave a better power factor and reduced loss. He thought the Scott-connected transformers were unnatural, and therefore unsatisfactory. He preferred a straight three-phase or single-phase type. He agreed that it was much more advisable to boost than to bring out tappings. With regard to the stresses due to short circuits in furnaces if there were no reactance, they had a case near the power station at Sheffield where the electrodes were let down before the man put in the main switch. They had a load of about 59,000 kw. at the time. The man was blown through the door, the main switch burst, and the whole of the 1 sq in. 11,000-volt mains in the street were volatilized. When running a large number of machines a regulator was not so necessary as when running only one machine. They had used at Sheffield an effective reactance which consisted of a lot of stampings, with an air gap, which was put round the low pressure lead.

Mr. R. G. Mercier thought the author had drawn his conclusions from the transformers supplied some time back. The troubles with the early furnace transformers were due to various causes. The makers were not then acquainted with the heavy surges coming from the electric furnace, and the makers of the furnaces installed transformers of too small a k.v.a. capacity. In two or three cases those small transformers were put in mainly in consequence of the guarantees the transformer makers gave of their heavy overload capacities. Transformers of 650 k.v.a. were then put in for 3-ton furnaces, whereas an 800 or 900 k.v.a. would be used to-day. A third contributory element to failures was due to users of the furnaces. If faults occurred in consequence of stripping the raising and lowering gear the electrodes would come down to the hearth and there would be a dead short circuit. If a switch would not trip, due to an accumulation of grit and dust and so on, the transformer had to bear the whole of the trouble. But to-day there were new conditions; transformers were of a higher k.v.a. capacity for a given size of furnace, and voltage and current regulators were used. At the works with which he was associated they had a 15-ton furnace using 3,000 k.v.a. A similar sized furnace a year ago had only used 1,500 k.v.a., and the transformers broke down. The 3,000 k.v.a. furnace had no very heavy surges because it was fitted in automatic voltage and current regulators. He thought that in future furnaces above 4 or 5 tons capacity would have these regulators. Furnaces of about 3½ tons generally had hand electric control and very small furnaces direct hand control. Another cause of trouble was the habit of users to take 5,000 or 6,000 amperes per phase on a furnace designed for 4,000 amperes. This raised the temperature of the transformers considerably, and in one case even caused sludging of the oil.

Dr. S. P. Smith said the author expressed a preference for sandwich coils, one reason being that the desired reactance was obtained more easily. Why did he particularly want the reactance ? Was it to safeguard the transformer ? With regard to the total reactance in the secondary circuit, the author said 32 per cent. in the leads represented perhaps as good conditions as one could get. In addition there was 7 per cent. in the transformer, making 39 per cent. altogether in that secondary circuit. He would be obliged if the author would give a little more information regarding the necessity for that internal reactance in the transformer. He (Dr. Smith) had a prejudice in favour of the core type transformer. Mr. Thompson showed him how to design shell type transformers, and it was a complicated job. Would it be possible to use a core type transformer for furnace work when the coils had only one to two turns, and if so could the coils be made concentric ? He was rather surprised that the author should use the sandwich type of coils in a core type transformer, because, as the author said, the cooling ducts were no good, being at right angles to the direction of flow of the oil. Could not the author use the concentric type of winding and obtain the reactance in the way he did with the high-reactance transformer for a rotary converter ? When using a booster would the author give the transformer high reactance or use the transformer with normal reactance and obtain any further reactance either in the booster or in the leads ?

Mr. J. R. Cowie thought the only advantage of the core type transformer was easy repairs. He had seen a big power transformer which was sent out by the manufacturers where the leads crossed and actually touched. He had had propositions put up to him for big transformers surrounded by smaller transformers to do the refining work. Cost of cable was an important matter ; 11,000-volt cable cost £3 per yard, and 22,000-volt £4 per yard, whereas figures of £1 to £1·75 and £2 were given for low voltage cable. The cost of switchgear ranged from 1 to 2·5 if 22,000 switchgear were used, and from 1 to 4 if very heavy high tension gear were used, and the cost of switchgear was generally a small proportion of the total. He did not like tappings coming out from the transformers. Progress was sure to be made on the lines of using regulators. There was a h.-t. regulator (which had not been mentioned) which gave ranges of 50 to 100 volts. It could be designed to give 20 per cent. regulation with a voltage not exceeding 600 volts on the regulator. In the author's curves he noticed the weight dropped, but the price did not drop at the same rate. That was due to the great difficulty of making a mechanical job of the big transformer.

Mr. G. E. TAYLOR said the company with which he was connected had three tappings on their furnace transformers. There had never been any fault at the tapping point. A certain amount of reactance was required in a transformer for steel furnace work. There was about 30 per cent. in the leads and about 10 per cent. in the transformer. In the first furnace transformer installed by his company the reactance in the transformer was made of iron shafts. That was no good in the furnace, one must have a reactance that obeyed the lineal law. On the Tees-side they had a furnace working which had a power factor taken over six months of 0·9 to 0·92.

Mr. H. W. CLOTHIER said the author had referred to the dangers due to failure of insulation on the transformer terminals. He thought they should set out to enclose all conductors. There should not be bare conductors on the high tension side, nor should conductors be coupled up with rubber cables and taped over as that was similar to a bare conductor as regarded danger of insulation failure.

The AUTHOR, in reply to the discussion, said Mr. Sayers had suggested that the tappings should be at the neutral point. That would not prevent the voltage piling up on those tappings if one happened to be working on the inside tapping when a surge occurred. Moreover, about 40 per cent. of the furnaces in this country were two-phase, and in those cases there was no neutral point. Another difficulty about tappings on the neutral was that the loading of the parallel conductors had to be balanced on the low pressure side, and to do that the tappings must be located in such a position that the reactance of the several coils was equal. The 1½ turns was a splitting up of the flux paths. The shell type transformer had two paths in parallel. He had tried to extend that by working it to ¼ and ⅛ turns and so on, but the difficulty was that the ampere turns per flux path had to balance. There were perhaps a dozen failures with core type transformers to one with the shell type. With regard to Major Taylor's remarks, the reactance of furnaces varied. He did not know anything about the Westinghouse statement. (Major TAYLOR: It appeared in THE ELECTRICIAN of of July 18, 1919.) He did not think the boosting would limit the power factor. It would increase the reactance of the circuit to a certain extent. He thought connecting the high tension windings with the booster at the next phase would be rather expensive in regard to switchgear. There was no difficulty in working furnaces at frequencies from 25 to 60 amperes, but the furnace people were of opinion that 50 gave the best result. He did not like Scott-connected transformers. The failures of the high tension tappings mentioned by Mr. Fedden were due in most cases to the tappings being placed at the ends of the windings and not in the centre. He did not think there was a furnace fitted with four sets of transformers as Mr. Fedden suggested. A better efficiency might be got in that way, but the cost would be much heavier. With regard to stresses in connection with the transformers the experience Mr. Fedden related could not have been a short across the low tension bars in the furnace, because no furnace maker or dealer would give any operating power factor to his furnace higher than 0·92. By having the sandwich winding on the core at the ends one got a straight line reactance, whereas with the concentric type of winding a straight line reactance could not be obtained within the limit required. It was possible to use a core type transformer with a low number of turns.

The Annual Physical Society and Optical Society Exhibition.

(*Concluded from page* 119.)

EVERSHED AND VIGNOLES.

Leakage Indicator.—Messrs. Evershed and Vignoles exhibited a useful type of leakage indicator. The principle of the indicator can be shown most simply in its application to a two-wire system as indicated in Fig. 21. A voltmeter V is connected with one terminal to the mid-point of a resistance R_1 R_2 across the mains and the other terminal to earth. If the insulation of both mains is the same there is no duplication; but, since the voltmeter has a scale with centre zero, if the insulation is unequal there will be a deflection, and the instrument is so connected that the deflection pointer deflects towards the indicator main which is at fault. The switch seen below the voltmeter in Fig. 22 is normally kept in the position to the left hand side so that the connections are as shown in Fig. 21. If, however, the switch is pushed over to the right the contact A is opened and the voltmeter then reads the voltage of the positive main to earth. If the switch is pushed over still further the voltmeter, the contact A is closed, but that at B is opened. The insulation resistance of either main can then be found at once by referring to a table which is supplied with the instrument. In the case of 3-wire systems the procedure is not quite so simple. A relay to ring a bell is provided if desired.

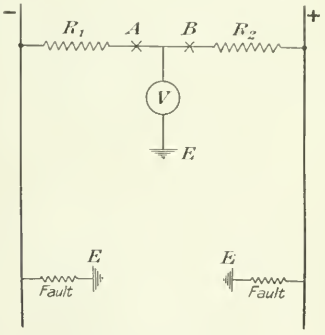

FIG. 21.—CONNECTIONS OF LEAKAGE INDICATOR IN THE CASE OF A TWO-WIRE SYSTEM.

Messrs. Evershed & Vignoles also showed an interesting motor generator giving 5,000 volts direct current for X-ray and other research work. The machine, which is illustrated in Fig. 23, consists of three small magneto-generators in tandem. Each generator is provided with four sets of brushes, each set serving its own winding and the four sets being connected in series. Particular care has been taken to produce an E.M.F. free from ripples. For this reason the generators are slightly staggered in respect to one another so that communication in one does not occur at the same motor as communication in another, and each generator is fitted with the condenser. The output is 15 milliamperes and the speed 3,000 r.p.m. An overload device is provided. Normally an armature closing the circuit is kept in the closed position by a permanent magnet. The latter is provided with coils carrying the main current, and if the current exceeds the safe load the demagnetising effect is sufficient for the armature to fall.

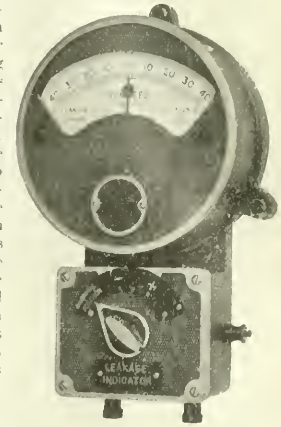

FIG. 22.—EVERSHED & VIGNOLES' LEAKAGE INDICATOR.

A number of exhibits were also shown by other well-known firms, but although of undoubted interest they did not present any par-

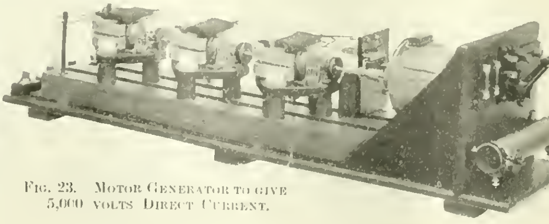

FIG. 23. MOTOR GENERATOR TO GIVE 5,000 VOLTS DIRECT CURRENT.

ticular points of novelty and do not call for any detailed description. These included Messrs Elliott Bros., Ltd., Messrs Nalder Brothers & Thompson, who both showed examples of their well known electrical instruments, Messrs. A. C. Cossor, Ltd., the Igranic Electric Co., the Dubilier Condenser Co., the High Tension Co., the Concordia Electric Wire Co., and the Westinghouse Cooper-Hewitt Co., Ltd. An innovation of a useful kind was the display of technical books by Messrs. Benn Brothers, the Cambridge University Press, H. K. Lewis, Charles Griffin & Company, Macmillan & Company, and the Wireless Press. The only complaint we have to make is that some of these stands (not only those showing technical books) were without attendants, which always seems a poor way of taking advantage of an exhibition.

A. Gallenkamp & Company.

Messrs. A. Gallenkamp & Company showed a number of interesting pieces of apparatus, including new apparatus by Mr. C. R. Darling. Among these we noticed a tempering furnace in which the limiting temperature was indicated by the magnetic character of the steel, on lines which have now become familiar. The indicator in this case consists of a coil in series with the furnace. Within the coil is suspended a piece of soft iron, which is capable of making a contact, completing a bell circuit. This little piece of apparatus stands on top of the furnace; when the steel is inserted the contact is adjusted so that the bell just does not ring, but as soon as the steel loses its magnetic qualities the soft iron armature swings over sufficiently to make contact, the bell rings, and the attendant knows that the required temperature has been reached.

Zenith Mfg. Company.

The Zenith Mfg. Company were showing a vibrating magnetic rectifier which they hope shortly to place on the market. This rectifier is primarily intended for charging small accumulators, and in particular those which are used for lighting and starting on motor cars. It comprises a small transformer with an open magnetic circuit, which is wound to reduce the main alternating-current supply to a voltage suitable for charging up to 12 cells connected in series. Suitably arranged around this transformer is a permanent horseshoe magnet between the poles of which a reed vibrates, carrying specially shaped copper contacts so made that when the reed vibrates it alternately touches on two adjustable carbon blocks, and thus causes the alternating current to be rectified into unidirectional impulses, which are quite satisfactory for charging purposes. The connections are shown in Fig. 24.

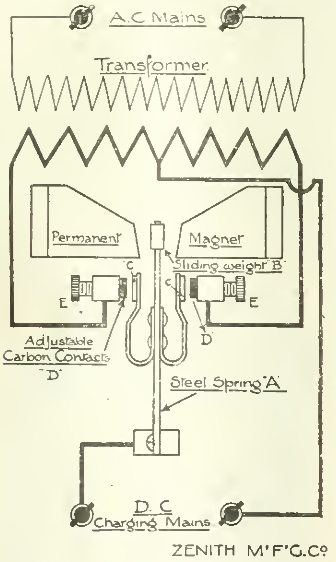

Fig. 24.—Diagram of Zenith Magnetic Vibrating Rectifier.

The rectifier has, we understand, been tested under working conditions for prolonged periods, and has been found quite satisfactory. The overall efficiency is not less than 60 to 70 per cent., mainly owing to the fact that the low voltage charging current is obtained by means of a transformer, and does not involve the use of ohmic resistances. It should be noted that both half-waves of the complete alternating-current cycle are used. When properly adjusted the sparking on the contacts is very slight, and there is ample adjustment for wear.

There are no expensive platinum contacts as in the older patterns. A new set of carbon and copper contacts can be supplied at the cost of a few shillings, but experience shows that renewals are only necessary after several thousand hours of work.

A marked feature was the great display of apparatus for wireless telegraphy. Some of these exhibits showed the evolution of the thermionic valve, such exhibits being shown by the Marconi-Osram Valve Company and the Edison Swan Electric Company. There was a beautiful exhibit by Mr. H. W. Sullivan which included oscillators, amplifiers, air-condensers and non-reactive resistance-boxes for high-frequency measurements.

Tree Telephony and Telegraphy.*

By Major-General GEORGE O. SQUIER.

(Chief Signal Officer United States Army.)

(*Concluded from p.* 112.)

Open-circuit Voltage.—The other quantity which serves to determine the characteristics of any antenna system is the open-circuit electromotive force *E*. The determination of this quantity is difficult, and its measurement so far has not been accomplished with reference to this particular problem, apparatus of sufficient sensitiveness being lacking. Indirect methods may, however, be used.

The open-circuit voltage of the tree system as an antenna has to be determined for different heights of contact and for different frequencies. To be of use in determining the behaviour of the antenna system, without reference to a particular sending station, this open-circuit voltage must be that for unit field strength of impinging radiation. This can be determined by dividing the observed value of voltage by the calculated field strength set up by the particular sending antenna.

To make observations a simple form of antenna for which the open-circuit voltage can be calculated in terms of the field strength may be used, such as a simple vertical wire. After the apparent properties at the various frequencies which are to be used have been determined, connect in series with this antenna (also shunting it by a capacity to ground if necessary) such resistance and capacity as to make its total constants equal to the apparent constants of the antenna whose open-circuit voltage is desired. Then arrange for the alternate connection of these two antenna systems to a receiving set and associated audibility meter. The readings of the audibility meter which give equal intensity of signals then correspond approximately to the square of the open-circuit voltages (Austin's Law for a Vacuum Tube Rectifier using a grid leak and a condenser). The open-circuit voltage of the simple antenna being calculable, the value of the voltage for the unknown system becomes known. If it is desired to eliminate from the calculations this law concerning rectification, the antenna may be loosely coupled to the receiving set and the coupling varied for the two systems until equal signals are received, thus eliminating the audibility meter—a device not at present very dependable. For equal signals the ratio of such coupling is inversely proportional to the open-circuit electromotive force because of the fact that the impedances of the two antenna systems were originally made equal.

With the receiving set tuned to give the best signal strengths, data concerning the audibilities at different heights of contact were obtained. These data are illustrated in Fig. 7, in which audibilities are shown as functions of the height of contact. The wave lengths are indicated on the curves. Very great increase in audibility occurs at about 12 metres height (about two-thirds of the total height of the tree).

Since the audibilities are approximately proportional to the square of the electromotive force applied to the receiving set used at a given frequency, it is instructive to consider the curves showing the square roots of the audibilities. Except for values above 12 metres in height these curves are quite closely approximated by straight lines. Theory would lead to the conclusion that the open-circuit voltage is a straight-line function of the height, and, since the receiving set was tuned to maximum sensitiveness for each reading so that the total reactance of the circuit was zero, the remaining quantity to which must be attributed the departure of these curves from straight lines is the variable (and in this case unknown) antenna resistance. It is to be noted that the height at which the audibility curves show their sharpest upward trend, which is also the same height for which the square roots of the audibilities depart from the straight-line relation, is also the height at which the apparent shunt resistance *r* reaches a minimum value in Fig. 5, for the wave-lengths involved in the audibility measurements.

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* Abstract of a communication to the Journal of the Franklin Institute.

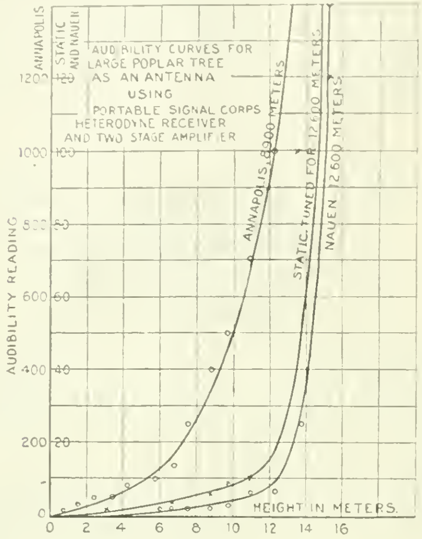

Fig. 7.

The term "open-circuit voltage" has been used. Such a means of specification of an antenna's properties corresponds closely to means of expression already in use, that is, to the "effective height," which is proportional to the open-circuit electromotive force for unit field intensity. It is usually considered as the height of the centre of the antenna capacity above the ground plane. It is only in order to lead to a clear conception of any antenna system as a particular form of the general electrical circuit that the term "open-circuit voltage" has been introduced.

Goniometric Methods Applied to Tree Antennæ.—One of the special lines of radio development caused by the war has been the application of radio methods to direction finding for military purposes. The Signal Corps has evolved and standardised certain sets possessing extreme compactness for the use of the mobile forces. Coil aerials of extremely small dimensions as compared with ordinary antennæ may be effectively used for both long and short-wave long-distance reception. It is therefore entirely possible to make use of such a coil aerial in combination with the tree system, without in any way detracting from the remarkable simplicity of the tree system, for the purpose of obtaining the desirable feature of unidirectional reception or so-called "barrage" effect.

Coil aerials of very small dimensions as compared with the wave-length received are nothing more nor less than ordinary inductance coils directly and magnetically exposed to the incoming electromagnetic wave, and may form the entire or the major portion of the inductance of a simple series resonant circuit. Such a circuit is shown in Fig. 8, consisting of the coil aerial *L*, the inductance L_2, and the capacity C_2. This circuit to which there is connected the detector and amplifier forms the secondary receiving circuit of the system, and is coupled inductively to the primary circuit L_1C_1 to which the tree and ground wires are connected at *T* and *G*.

The system is unique in that both primary and secondary circuits are directly exposed to the incoming wave. It is by virtue of this double exposure that the unidirectional characteristic of the system is obtained. Both primary and secondary circuits are simultaneously operated upon by the incoming electromagnetic wave and by the proper adjustment of the linking coils L_1 and L_2, the effects produced in the secondary circuit may be entirely neutralised or accumulated. Switch *S*, shown in Fig. 8, is a reversing switch connected to coil L_2, which controls this neutralising or accumulating effect. Complete "barrage" effect was obtained with this system on stations such as New Brunswick, New Jersey; Annapolis, Maryland; Nauen, Germany, &c. This makes it possible, for example, to receive signals from San Diego, California, while the New Brunswick station is operating and using practically the same wave-length as the San Diego station. The coil aerials used in the experiments made with the system above described are but 4 ft. square, and, therefore, are located within the station, merely forming a part of the internal receiving apparatus, and in no way complicating the simple tree system.

We have then a simple two-circuit receiving system requiring no extensive and costly outside aerial structure, and have the following modern features: (*a*) Long-distance reception at any wave length; (*b*) direction finder giving not only the line of direction but the absolute direction; (*c*) elimination of interference by virtue of the unidirectional characteristic or "barrage" effect; (*d*) simultaneous reception of two or more wave lengths or of two similar wave lengths coming from opposite directions.

Hitherto, in existing operating stations, the receiving circuits have operated primarily on the generation of alternating currents in the receiving antenna system, and, therefore, it has been necessary to tune the antenna system itself to the particular frequency of the signals. In the experiments in tree telephony and telegraphy, we may rather consider that we employ an aperiodic system in the form of the tree itself, and make use of the resultant potential effects at the upper tree terminal of this antenna, selecting from this reservoir of all frequencies the particular frequency desired, by means of external receiving devices now known to the art.

Potential Earth-Terminal.—We may regard the metallic electrode rigidly driven into the living organisms of a tree, as a potential earth-terminal for the study of the potential distribution on the surface of the earth itself. It has been shown that this metallic terminal intimately connected to the earth itself, and a part thereof, is subject to changes of potential representing the innumerable frequencies required by modern radio telephony and telegraphy as well as any other electrical disturbances which may occur on the surface of the earth or the atmosphere above the earth.

It has been also shown that we can select from this composite one or more of the different frequencies by tuned electrical loop circuits suitably connected to this electrode and study each in turn at will just as colour screens can select a particlar component of white light. We may, indeed, by means of a highly insulated conductor bring this terminal directly to the laboratory and connect it immediately to the modern thermionic tube and amplify almost at will the particular effects we are studying. This tube is a power ful and new instrument of research for the modern physical laboratory. Has not the physicist therefore in this electrode a means of studying in detail atmospheric and earth electrical disturbances of absorbing interest and far-reaching importance?

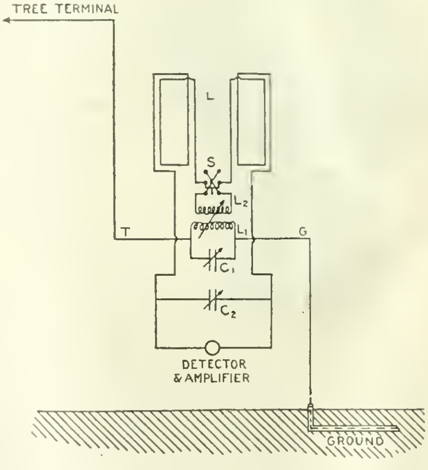

Fig. 8.

The physicist and engineer, accustomed to deal with inanimate material, is here confronted with the employment of living vegetable organisms of growing trees. From the moment an acorn is planted in fertile soil, it becomes a "detector" and a "receiver" of electromagnetic waves, and the marvellous properties of this receiver, through agencies at present entirely hidden from us, are such as to vitalise the acorn and to produce in time the giant oak. In the power of multiplying plant cells, it may, indeed, be called an an incomparable "amplifier." From this angle of view we may consider that trees have been pieces of electrical apparatus from their beginning and with their manifold chains of living cells are absorbers, conductors, and radiators of the long electromagnetic waves as used in the radio art. For our present purposes we may consider, therefore, a growing tree as a highly organised piece of living earth to be used in the same manner as we now use the earth as a universal conductor for telephony and telegraphy and other electrical purposes.

Heating and Cooking Notes.

"Creda" Heating Accessories.

Messrs. Credenda Conduits, Ltd., signified the arrival of the New Year by distributing a four-page leaflet concerning "Creda" irons, kettles and porringers. The element is made of nickel-chrome ribbon mounted on mica sheet, special attention having been given to providing adequate heat at the point of the iron. This is a good feature because the front portion of an iron is used far more than the back. A sheet metal device fixed at the back of the iron provides a serviceable stand and obviates the necessity of using a separate iron stand. The connector is not only designed to provide freedom from mechanical strain on the flex where it enters the terminals, but a spiral wire guard protects the flex against fraying and wear.

Two sizes are made: No. 1 having a consumption of 300 watts, and No. 2 500 watts, the weights respectively being 4 lb. and 6 lb. For industrial purposes a slightly less expensive iron is made which comprises all the main features of the household irons with the exception of the stand device. There are also listed a goose iron, billiard iron, and a Universal iron for use when travelling.

The "Creda" kettles are made of copper with self-contained, easily replaceable elements, mounted in the base of the kettle. They are supplied complete with connector. The capacities vary from two to eight pints and four distinct patterns of kettle are made. Small milk and water heaters are also offered in the range of "Creda" cooking accessories. A new and welcome addition to the "Creda" family is a porringer made of copper and fitted with a china interior. Three sizes are listed, 1, 1½ and 2 pints capacity. All the articles are well finished and offered at reasonable prices in comparison with present-day costs for material and labour.

The General Electric Company, Ltd.

The issue of a 26 page catalogue of "Magnet" heating and cooking apparatus is an evident sign that this firm are getting back to pre-war activity in this branch of the industry. Magnet fires are shown in three styles of frame, Cast Iron, Polished Brass and Copper, and Glazed Earthenware, the range comprising six styles of design. The loading of the heaters ranges from 660 watts to 2 kw., and the usual sizes being 1·5 kw. and 2 kw. The glazed earthenware fires are illustrated in Fig. 1. There is evidently still a demand for the lamp type of radiator, for eight different designs are listed of this type of heater. Convectors are offered in four different styles, two of which are suitable for use in factories where conditions are such that the elements must be totally enclosed. One of these is suitable for wall mounting and the other is a vertical type of heater standing on a pedestal base. The latter can be fitted with heating surface on two sides when the heater is to be fixed in the middle of a room or with one heating surface only when fixed close to a wall. The wall type of heater consumes 500 watts, and the pedestal type is made in four sizes with a range of consumption from 750 watts to 1 75 kw. A large range of kettles, saucepans, water and milk boilers, urns, frying pans, hot plates and warming plates are listed.

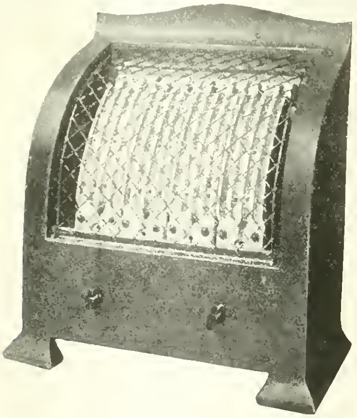

Fig. 1.—G.E.C. Fire with Glazed Earthenware Frame. (Palissy type H.O. 1937.)

In Fig 2 we illustrate a neat little combination outfit which should provide a very serviceable method of introducing electrical heating and cooking apparatus into the homes of lighting consumers. The underlying feature is the provision of a stand which enables an electric iron to be used as a hot-plate and the set comprises either a 4-lb. or 6-lb. iron and stand together with a kettle, frypan and saucepan.

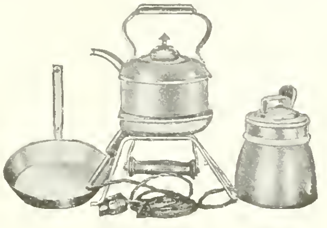

Fig. 2.—"Magnet" Outfit for Ironing, Boiling, Frying and Stewing.

Another interesting outfit of similar description is intended for the convenience of ladies when travelling. It comprises a universal voltage iron which can be used on all circuits from 100 to 125 volts, or 200 to 250 volts, with a stand and receptacle for boiling water, together with a curling-tong heater. The whole of the apparatus packs up into a small attaché case which is sold with the set.

A variety of styles of domestic, laundry tailoring and industrial irons are listed, all of which are fitted with "Magnet" easily replaceable elements, and careful consideration seems to have been given to the design of the terminals and connectors in each case, so that the flex is not only adequately protected but is led away in such a manner that it will not hinder or impede the operation of the iron. Such provision naturally prevents the use of one standard connector for all irons, but it certainly adds to the efficient operation of the iron. Electric cookers are represented by three types: firstly, the usual type of cast-iron range with hot-plate, grill and lagged oven; secondly, two portable types of ovens, one with sheet metal lagged carcase and hot-plate fixed at the base of the oven, and the other a plain sheet metal oven mounted on the top of a radiant grill. This is a novel way of providing an expensive cooking equipment suitable for baking, roasting and grilling, and we illustrate the apparatus in Fig. 3 showing the oven mounted on the grill. The elements consist of two circuits of 750 watts each, and heat control is provided by means of rotary switches mounted on the side of the grill.

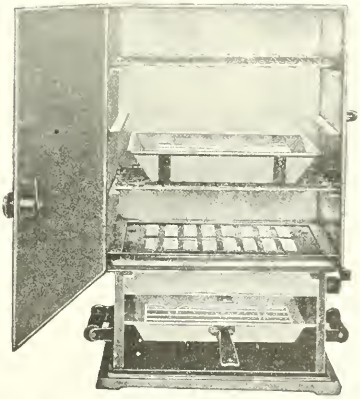

Fig. 3.—"Magnet" Model A. Portable Oven and Grill.

Provided that the oven is kept bright this apparatus should provide an efficient method of cooking, involving only small capital expenditure for the apparatus. In small flats and houses the advantages of compactness and portability are a distinct gain. Where it is desired to provide complete cooking facilities self-contained electric saucepans and kettles can be added and used off a plug board mounted in a convenient position. The whole apparatus and accessories can then be used on a small kitchen table, and stored away under the table when finished with. In addition to details and prices of a large range of appliances useful information is given concerning the principles and advantages of electrical heating and cooking. To deal adequately with all the good things contained in the catalogue is impossible in the space we can devote to it; but we would recommend every contractor and supply authority to send for a copy of this catalogue as it forms a veritable encyclopaedia concerning heating and cooking apparatus.

American Competition.

Reports from America all seem to point to increasing difficulties with labour, not only in the industrial world but also in domestic life. Domestic labour was always scarce in the U.S.A., but the war seems to have increased that scarcity and raised the cost of what labour is available to a prohibitive point. Under such circumstances it is only to be expected that there is a keen demand for household cooking and heating appliances, and American manufacturers are at present unable to satisfy it. It is, therefore, up to the English manufacturer to commence actively supplying the British market with sound apparatus at as reasonable a price as bulk production and existing conditions will permit. Then, when the American manufacturer is in a position to export, the British market, adequately supplied by English firms, will not look so tempting. It is an unfilled market that attracts far more than one which is already adequately supplied both as regards quantity and price.

Review.

The Essentials of Alternating Currents. By W. H. Timbie and H. H. Higbie. (London: Chapman & Hall, Ltd.) Pp. viii. + 374. 8s. 6d. net.

This book is of American origin, and is an ambitious attempt to initiate the general trade worker into the principles underlying alternating practice without the use of much algebra or trigonometry. It starts off boldly in the first chapter with central power stations and power transmission. Many different types of machines are referred to, so evidently the reader is assumed to have had a wide experience of alternating-current machinery before commencing the book.

Chapter II. begins with transformers, and some attention is given to a bell-ringing transformer, an illustration of the external metal case of which appears on one page. Paragraph 12 purports to be about the magnetic field due to an electric current in a coil, but only refers to a straight wire. The magnetic field is spoken of as "whirling around the wire." Diagrams 23 and 24 are supposed to show the field about a wire, by the aid of iron filings and magnetic compasses in 23, and iron filings only in 24. What the oblongs marked N and S are is not explained in the text. The description of the action of a transformer, on page 39, leaves much to be desired. On the same page the power in watts is spoken of as the product of the voltage times the current. Subsequent chapters discuss impedance, resistance, reactance, polyphase circuits, motors, starters, controllers, converters and rectifiers.

For a book intended for electrical tradesmen the methods adopted by the authors to inculcate the "Essentials of Alternating Currents" would appear to be capable of improvement. Some of the chapters are too descriptive, and a large number of various types of electrical machines are referred to at a very early period, with little or no explanation as to their use. Some of the diagrams are poorly drawn and others are misleading—*e.g.*, diagrams 28 and 51, sections of current-carrying solenoids, show only leakage flux, with no main field. More emphasis should be given at the beginning of the book to the fundamental principles underlying alternating-current phenomena. There is a tendency to develop a rule which will give an answer to a numerical question, rather than to give an explanation of what is occurring in any circuit under consideration.

H. F. Haworth.

Correspondence.

ELECTRIC *VERSUS* STEAM LOCOMOTIVES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to an article on "Electric *versus* Steam Locomotives," which appears in the current number of The Electrician, in which you quote from the "Scientific American," I thought the following extract from the "General Electric Review" on the same subject would be interesting to your readers, and also, while not giving the actual horse-power of the steam locomotives, give you a reply to the latter part of your article.

"After luncheon, regenerative braking tests were made with two steam locomotives obtained from the New York Central Railroad for this purpose.

"One of these was a high-speed passenger locomotive of the Pacific type, having a total of 173,000 lb. on the six drivers. The second was a freight locomotive of the mountain type, having eight driving wheels, with a total 234,000 lb. on the driving axles. The principal data of the two engines are as follows:—

—	K2 passenger.	4-1 freight.
Wheel arrangement	4-6-2	4-8-2
Weight, lb., engine and tender	421,000	509,500
Weight, lb., engine and tender	276,800	343,000
Maximum tractive effort (at starting), lb.	29,150	51,400
Diameter drivers	79″	69″
Total wheel base	36′ 6″	38′ 11″
Rigid wheel base	14′	18′
Overall length, engine and tender	77′ 6½″	82′ 1⅝″

"For the regenerative braking tests the three engines were coupled together, the electric locomotive leading. After all three had accelerated to 25 miles per hour, the two steam engines made their best endeavour to push the electric locomotive faster, but were prevented from doing so by the application of regenerative braking on the electric locomotive."

"At times, as much as 2,000 kw. was returned through the sub-station to the Erie works . . . ."

"As a concluding event, a braking test was made of the two steam locomotives against the electric, in which the electric locomotive easily pushed back the two steam engines, in spite of the throttles of the former being wide open."

I hope that the electrical fraternity of this country will take more interest in the question of heavy railroad work than what is being done, and, along with other branches of our trade or profession, the research work will not be allowed to be all done by other countries. We have not the enormous natural resources that they have in Switzerland, Italy and America; but the problems in our country, such as dearness of the coal supply and increased cost of labour, will force our railway companies sooner or later to electrify, and it behoves us all to be prepared when that comes, and not allow the orders to go abroad. I am, &c.,

Liverpool, Jan. 31. Charles Rettie.

COAL (PIT'S MOUTH) PRICES ORDER AND DIRECTION, 1919.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: A point has been raised in regard to the question of "coal delivered during the month of December, 1919," as referred to in the Coal Controller's "Prescription," and, in reply to my query to the Coal Mines Department, I have been informed as follows:—

> Coal for electricity undertakings which was despatched from the colliery prior to the 1st December is not subject to the reduction of 10s. per ton under any circumstances.
>
> The term "delivered" in the prescription was used in explaining the method by which the amount of deduction was to be computed, but the Coal (Pit's Mouth) Prices Order and Direction, 1919, makes it quite clear that only coal despatched from the colliery on or after the 1st December is subject to the reduction."

I shall be glad if you could kindly give publicity to this explanation.—I am, &c.,

London, Feb. 3.

T. W. Cole, *Secretary*,
Provincial Electric Supply Committee
of the United Kingdom.

The Electrician.
FRIDAY, FEBRUARY 6th, 1920.
Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

The Protection of Power Stations.

One of the arguments against the generation of the country's electricity supply in a few capital stations is that it would allow any riotous or illegal element in the population that was so minded to deprive a very large district of its light and power with a minimum of trouble and at a slight risk to itself. This argument, though it need not be taken too seriously when stated in this form, is one, however, that has a basis of fact. A generating station is admittedly a vulnerable point—and light and power, especially the former, are necessary to the conditions under which we live. This applies equally to a small number of large stations as to a large number of small ones, and to gas works as to electricity stations. It is, therefore, important that every reasonable means should be taken to protect plant of these kinds from damage, and thus to minimise the possibility of urban areas being without artificial light, even for a short period.

Crime seems, unfortunately, to be increasing, and it would certainly increase very much more rapidly if adequate lighting at night were not provided. Conditions in Chicago exemplify this, a reduction in the street lighting there being immediately followed by a number of robberies and assaults in the darkened streets. There is another point which must be considered. For while we do not suppose that this country is in imminent danger of attack, it is agreed that the next war will be largely in the air. Such attacks will be speedy and unheralded. It is worth while, therefore, to consider the protection of power stations from this point of view and to determine some policy for their adequate defence.

INSURANCE NOT OVERINSURANCE.

It is obviously possible to turn a power station into a fortress. But no one would seriously suggest that this should be done. For while to spend a certain sum on protection would be an insurance it is inadvisable to overinsure. The question that has to be decided then is exactly how protection can be afforded with a minimum outlay of what must be unproductive expenditure. It is obvious any permanent defence would necessitate both large capital and revenue accounts and probably largely defeat its object by lulling people into security. The best form of protection would be one that could be put into working order in a moment, but here again it is difficult to see exactly what form this should take, without an expenditure out of all proportion to the benefits conferred.

PROTECTION AGAINST AIR RAIDS.

Of the two problems protection against air raids would seem the easier, for little or nothing need be done at the station itself. The chances against any particular station being hit in a raid are great. London and other large towns suffered recurrent attacks from enemy aircraft during the war, yet the generating stations were left almost unscathed, and the same might be said of mains. In the case of generating stations in urban districts we do not think, therefore, that their protection against attack by aircraft need be considered separately from the requirements of the district itself. We hold the opinion, which is, we think, one which is also subscribed to in official quarters, that the best form of defence against aerial attack is a counter attack by our own aeroplanes. This form of defence also has the advantage that it can be put into operation as and when it is required and would need no special precautions to be taken at the station itself. In the case of an actual landing by hostile troops the case would, of course, be different, and may be considered with what we say below about protection against civil disturbances.

PROTECTION AGAINST CIVIL DISTURBANCES.

In dealing with protection against civil disturbances, the imagination may be allowed to run riot without any more useful purpose being served than is usual with riots. Extensive military works, such as trenches, barbed wire entanglements and pill boxes, might be erected around each station; but, apart from the question of cost, the difficulty about any systems of protection of this kind would be that troops would be required to man them. And unless it is also proposed that a battalion of infantry should be permanently encamped in the neighbourhood of each generating station the damage all these works were supposed to prevent might be done before the troops could reach the spot. Any arrangements adopted must therefore be less blatantly military, and the best protection would seem to be to design the station so that unauthorised persons cannot easily obtain an entrance. In a word, an extension of the useful commissionaire principle which is employed at most of them already.

To some extent, of course, electricity is its own protection against the unauthorised and the ignorant. An attack made by a mob on a high-speed turbo-generator or on "live" extra-high-tension switchgear would be even worse for them than the locomotive was for the "coo." While the same might be said of any attempt to attack live feeders with a pick and shovel, as certain members of the *genus* navvy have already found to their cost. The attack might, however, be headed by someone who knew something about the working of a station or by a band who compelled the staff to carry on under the "peaceful persuasion" of pointed firearms.

THE FORM PROTECTION SHOULD TAKE.

Protection should, therefore, be obtained by enclosing the station by a wall or unclimbable fence and by allowing entrance to the premises only through a narrow entrance so that in case of need the way could be held by a few. Protection from the river side would be more difficult, but not impossible, while the installation of steam and water hoses to cool the spirits and bodies of the more venturesome might also be suggested. Any attempts to put a generating station out of action would probably be made at night when efficient protection can be given by using searchlights and display lighting to illuminate the possible approaches.

DEFENCE NOT DEFIANCE.

Our reasons for discussing this question are not that we suppose any concerted attack is to be made by the disaffected on the generating stations of this country. But neither war nor civil commotion are, unfortunately, ever remote from the bounds of possibility. Such occurrences are much better prepared for than left to chance. We would sooner see money spent on insuring the continuity of electricity supply by every legitimate means than that towns should be plunged into darkness and greater expense incurred by damage caused to property by riotous elements. The whole thing is mainly a question of insurance and is well worthy of the consideration by the authorities which we hope it will receive.

North-Eastern Centre I.E.E. Dinner.

The Annual Dinner of the North Eastern Territorial Centre of the Institution of Electrical Engineers was held at Newcastle-on-Tyne on Friday last. Mr. W. Cross, the chairman of the Centre presided, and among those present were the Lord Mayor of Newcastle (Councillor Walter Lee), Mr. Roger T. Smith, Dr. C. C. Garrard, Messrs. H. Shaw, J. S. Highfield, J. E. Sayers, B. Welbourn, W. B. Woodhouse, Prof. W. M. Thornton, J. H. Holmes, L. B. Atkinson, P. V. Hunter, A. P. Pyne, H. W. Clothier, P. F. Rowell and L. H. A. Carr (hon. secretary of the Centre).

Mr. A. P. Pyne, in proposing "The President and Council of the Institution," spoke of the large field covered by electrical engineering and of the enormous responsibility shouldered by the President and Council of the Institution. He explained that it was achieved by means of some 50 committees and sub-committees dealing with various subjects who reported direct to the Council.

The President, in reply, said that during the war the idea of service had gripped individuals of every class, but now, probably through the reaction following the war and also from a habit which had been growing before the war, the wage-earner had lost this idea. He had demanded a shorter day and rightly so, but in order that he might enjoy it, professional men and other members of the middle classes had to work longer and harder without extra pay. The intellectual Socialists had always claimed that service for the State was the ideal. Some of the statements concerning Nationalisation, however, had, he thought, to be taken with a grain of salt, and it seemed to be left to the professional and middle classes to show that organised selfishness was not the only way in which our social and industrial life could be continued.

Other toasts were proposed by Mr. H. W. Clothier and Mr. J. R. Beard and responded to by the Lord Mayor of Newcastle and Mr. R. Shaw, of the Newcastle Chamber of Commerce.

During the evening a musical programme was given by members of the Centre. This included songs by Messrs. Elder, Fowles, Westwood, Anns and G. N. Wright, Mr. Collins acting as accompanist. Selections on the auxzetophone operated by Messrs. Carnegie and Drummond were also given.

"Sun" Staff Peace Dinner.

Over 100 members of the staff of the Sun Electrical Company, Ltd., foregathered at the Cafe Royal, Regent-street, London, on Saturday evening last to celebrate the return of those who joined the Forces during the Great War. The general manager, Mr. A. G. Beaver, presided over a company which included several directors. The lady members of the staff were well represented. After the loyal toast

The Chairman gave that of the "Sun Boys who did their bit," remarking that 50 per cent. of the eligible staff joined up early in the war and a further 25 per cent. was subsequently taken. Of this number one only failed to return.

Mr. A. J. Wood, in reply, referred to his experiences during the many air raids on Dunkirk, where he was stationed throughout the war.

The toasts of "The Directors," "The General Manager," "The Indoor Staff," "The Outdoor Staff and Agents" and "The Press" made a formidable list which was, however, enthusiastically got through. The relations between the management and the staff are most cordial, and there were many evidences of this during the evening.

The toast of "The General Manager," given by Mr. H. C. Weeks, the company's representative for 18 years, was musically honoured.

Mr. A. G. Beaver, who was the recipient of a handsome silver entrée dish and cigarette case, in his reply spoke feelingly of his appreciation of the gift and of the spirit of the staff which prompted it. He would always value the book of signatures of the donors, which accompanied the presents. He said the company had made great progress, and in August 1920 would celebrate its 21st birthday; this development was largely due to the loyalty of the staff.

The speeches were punctuated with an excellent musical programme and the whole event was greatly enjoyed by all present. As the first staff dinner it was a huge success. A souvenir programme, designed by Mr. E. R. Morton, the works and publicity manager, and bearing portraits of the directors and heads of departments, was distributed.

British Industries Fair, Birmingham.

Everybody who has experience of travelling knows the many difficulties—in fact, in most cases, the impossibility—of obtaining hotel and other accommodation at present, but a scheme which the Reception Committee of this Fair has inaugurated promises to overcome all difficulties, notwithstanding the heavy demands which are certain to be made on the City's accommodation during the Fair. The committee propose that all exhibitors, residing outside the area, should leave the hotels as far as possible free for the buyers who will attend, and the General Manager undertakes to reserve apartments for such exhibitors and their assistants, if an immediate intimation of the number of persons and the length of visit is given to him. The committee has made an earnest appeal to all local exhibitors to entertain at least one buyer, who is personally known to them, each night. Such an arrangement will free the hotels considerably, and the committee's further arrangement with the latter will ensure a maximum of this class of accommodation too. All that is now needed to ensure both visitors' and exhibitors' comfort and convenience is their co-operation, and this is asked for by the General Manager in the form of an immediate intimation of their requirements. The committee's scheme is a good one, and we would ask readers interested (either as exhibitors or buyers) and who have made no other arrangement to advise the General Manager of the accommodation they will need. It would be well to state again the details of the Birmingham Schedule, which are as follows:—

Lighting Fittings (Electricity, Gas, Oil); Cooking Stoves and Utensils (including Aluminium and Enamel Ware); General Hardware, Tools, Metal Furniture, Perambulators, Nautical Instruments, Firearms, Fishing Tackle, Machine Belting, Rubber Goods (Industrial and Household), Cycles, Motor Cycles, Accessories (for Motor Cars, Cycles, and Aeroplanes), Weighing Machines, Sanitary Apparatus, Paints, Varnishes, Metal Work, Ropes (Steel and Hemp), and Saddlery and Harness. It is only in Birmingham that the lines included in the above schedule will be on view. The leading firms in each branch of industry covered will be represented at the Fair, which will be open only to the accredited representatives of business houses at home and abroad, all of whom will be there by invitation issued either by the Board of Trade or the exhibitors themselves. Though the Fair does not open until Feb. 23 it would be well to make all arrangements in good time so as to avoid disappointment. To write now will materially help the Reception Committee and ensure the visitors' comfort. Letter of advice should be addressed: General Manager, British Industries Fair, Chamber of Commerce, Birmingham.

Bread Delivery by Electric Vehicles.

In reference to the article on this subject which appeared on page 124 of our last issue, our readers will be glad to learn that some firms in this country are also using electric vehicles for the delivery of bread. We are informed that a considerable number of firms mentioned in our last issue are employing G. V. electrics, which have been used for the purpose of bread distribution for a good many years in the States. One of the principal firms in London, and who might be said to be pioneers in this respect, is Messrs. J. Lyons & Company, of Cadby Hall, Kensington, W. This firm have at present four of the General Vehicle Company's 2-ton, four 3½-ton and one 5-ton vehicles in use for the delivery of bread and confectionery. The 5-ton vehicle was built with a specially large body, not on account of the weight carried but on account of bulk, so as to carry the greatest amount possible. The illustration shows a fleet of the G.V. vehicles used for bread delivery.

Motor Show at Glasgow.

The Scottish Motor Show was opened at the Kelvin Hall, Glasgow, on Friday, Jan. 23, by Lord Weir, President of the Scottish Automobile Club. During its continuance there was a large attendance of visitors from all parts of the country, and the show was generally voted the best of its kind held outside of London. The Kelvin Hall is admirably suited for such an exhibition. The system of lighting was by half-watt lamps hung in rows from the ceiling, and the illumination was uniform throughout, no facilities being provided for any kind of flood lighting on individual exhibits.

One hundred makes of cars were shown as against 129 makes at the Olympia show, but the Glasgow show included 39 commercial makes, whereas the Olympia exhibition was confined to touring cars. On all the days on which the exhibition was open a large amount of business was done. Many of the exhibits showed signs of having been hurriedly finished to be in time. Otherwise satisfaction was universal with the general excellence of design and workmanship in all the best known makes.

The Roles-Royce car retains its premier place, but the Lanchester car was a centre of attention and interest, owing to its being a likely rival of the Roles-Royce in the motor car world. The Hispano-Suiz car was an excellent exhibit, and in the opinion of many experts this car has a great future. The G.N. toy car proved a centre of attraction to many visitors.

With the exception of the Tilling-Stevens exhibit, electricity was absent from the show as a propulsive agent. In accessories, however, it was a very different story. All the best lighting and starting equipments were electrical. The lead battery seemed to maintain its supremacy for auxiliaries.

The most striking announcement was that for immediate delivery, but this applied only to American cars. British makers only seemed to be able to give more or less vague promises of delivery some months hence.

Legal Intelligence.

Electric Lamp Patent.

In opening the defence in the action brought by the British Thomson-Houston Company, Ltd., against the Corona Lamp Works, Ltd., for infringement of patent, &c., Mr. Kerly, K.C., said he attacked the patent on two grounds, viz., that the ambit of the monopoly claimed was not sufficiently defined and that, having regard to prior specifications, there was no invention. He attached the greater importance to the subject matter, but the question of the definition was a serious matter for consideration. The question whether the definition was sufficiently precise had two aspects ordinarily: the more important aspect was—Had the inventor sufficiently described for a user of the patent what he proposed to do? The other aspect was: Had he sufficiently indicated the limits of his monopoly so as to show what ground was left open and uncovered by his monopoly? His lordship would have to answer these questions:—Was there a definite invention? If not, there was nothing to define. Was it clearly and definitely stated in the claim so as to show what was left uncovered and free—and incidentally how to work it? Was the suggested delimitation a fair construction of the claim? Was there subject matter? The fifth and last question was: Had the infringement been proved? He quoted the law on the subject of definition and said that he could assume that there was a good invention here if it had been properly defined. He contended, however, that the inventor had claimed a bigger monopoly than he was entitled to by his supposed invention. He submitted as a general proposition which was sound and also was good law, that no definition which depended upon prolonged experiments to be made by a person who desired to find its limits and then only defined the ambit for particular members of the combination claimed could possibly be sufficient for patent purposes. Counsel said a statement had been got out by plaintiffs' accountant showing the sales of lamps by the three companies in what he called "the ring," viz., the General Electric Company, Siemens Dynamo Works and the British Thomson-Houston Company. He had no doubt that the figures were correct, but he would like to know what was the number of ordinary tungsten vacuum lamps sold in the last five years. Defendants' estimate was that it would be about 60,000,000 a year.

Mr. Colefax, K.C., for plaintiffs, said the figures for gas-filled lamps was actually 5,905,932 for the period 1914-1919. There had been a very rapid increase in the sales. In 1914 they were 41,000, in 1915 (280,000), 1916 (452,000), 1917 (1,109,000), 1918 (1,727,000) and 1919 (2,296,037). During the war there was great difficulty in getting the goods, because the manufacture of electric lamps was controlled. He happened to know, because he was the controller. One difficulty was the glass bulbs, and another difficulty was argon, which was made in Holland. With regard to the sale of tungsten vacuum lamps by the three companies for 1919, the figure was 9,589,208. The total sales of all lamps for that year was 11,885,245.

Mr. Kerly, proceeding with his opening speech, said that he was not looking for a statement in words that one had to take a thick wire in one's gas-filled lamp, nor for a statement that one had to take a coil of wire, but he would say that he would find in plain language in those documents that if one had a gas-filled lamp one could run the filament to give a greater brilliancy, and that that could be done because the lamp was gas-filled without undue danger to the life of the filament, and that it was the presence of the gas in the lamp which told one that one could run to a higher temperature with a corresponding higher brilliancy than was possible in a vacuum lamp. It was in order to get the possibility of that higher temperature without danger to life that one employed the gas, and it was for that purpose that it was employed in the prior specifications.

Mr. Ballantyne, analytical chemist, said the idea of a gas-filled lamp and of a metal filament for a gas-filled lamp was not unknown at the date of plaintiffs' patent, and he referred to an article in the "General Electrical Review" on "The Nitrogen-filled Lamp."

Mr. Percy R. Smith gave details of comparative tests of a Mazda ½-watt lamp and a Corona lamp, and Mr. Atkinson Adam said the tests were designed to show what efficiency the plaintiffs' lamp was giving.

Counsel addressed the Court on Tuesday, when his lordship intimated that he would reserve judgment.

Workmen's Compensation.

At Bow County Court last week, Judge Graham, K.C., gave a considered judgement on the claim of Ed. Hauxwell, an assistant engine-driver, for an award of £1 a week, or £150, from the Charing Cross, West End & City Electricity Supply Company. The facts were given in our issue of the 16th inst. The man was cleaning the engine pit, when a ladder fell and he fractured his right wrist. He was paid compensation for a time and then went back to work, but found it difficult to turn the levers with his injured wrist. Then he was dismissed, but his Union took up the case and the man was taken on again to help in cleaning out street boxes, for which he was being paid £3 10s. a week (instead of £4 12s.). The defence was that the man absented himself from work for three days without notice. He was a war-time hand and as a number of the company's employees were being demobilised his place was filled.

His Honour found that the defective grip and the inability to revolve his hand, of which applicant complained, did not prevent him from doing the work he was doing before the accident, and he dismissed the application with costs.

Commercial Topics.

British Trade with Scandinavia.

Mr. Montague Villiers, Commissioner in Scandinavia for the Overseas Service of the Federation of British Industries, who was in Birmingham last week and interviewed many Midland manufacturers upon the possibility of trade with Norway, Sweden and Denmark, emphasised the great development of hydro-electric power in those countries. From the electrical standpoint there were great possibilities, and at the present time unique opportunities were afforded for the development of trade in electrical plant and machinery, electric lighting fittings, &c.

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L.C.C. Loans for Electricity Supply.

The London County Council has increased the rate of interest on loans to local authorities to 5¾ per cent. By sec. 19 of the Electricity (Supply) Act, 1919, the Council ceases to be the sanctioning authority for borrowing by Metropolitan Borough Councils under the Electric Lighting Acts, and the duty of sanctioning them is transferred to the Electricity Commissioners. Pending the appointment of the Commissioners, there is no appointed authority for the sanctioning of these loans, but the Board of Trade hold that the Council should continue to sanction loans until the Commissioners are appointed. The County Council is taking steps to ascertain what advice the Electricity Commissioners will desire to have from the Council, and to what extent they wish the Council to examine applications for the loans in question.

The periods allowed for the repayment of loans recently granted by the County Council are as follows:—Mains 25 years, plant and boilers 15, house services 12, meters 10 and powdered fuel plant 10 and building works 30 years. In the main these periods are the same as those allowed by the Ministry of Health, but the latter allow 20 years for generating plant and only 5 years for meters. In view of the interest manifested in powdered fuel, the term allowed for the first loan of the kind will be noted.

In regard to an expenditure of £33,000 for coal-conveying plant at the Council's Greenwich power-station, the special period of 15 years has been fixed for repayment, and the outstanding debt (about £6,000) on the original cranes and plant will be repaid within 5 years.

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The Reorganised Board of Trade.

Another stage has been reached in what is termed the scheme for the re-organisation of the Board of Trade, which has been under consideration since June last. From the long official announcement we learn that the duties of the Department are now organised under two joint permanent secretaries: Sir Sydney Chapman, K.C.B., who deals with questions affecting general policy, and Mr. H. A Payne, C.B. (Controller), who deals with administration and finance. The re-organisation would seem to consist—at least in part—in changing the titles of old departments and in creating some new ones. The principal permanent Departments are now as follows:—Marine, Mr. C. Hipwood, C.B. (Assistant Secretary); Commercial Relations and Treaties, Mr. H. Fountain, C.B., C.M.G. (Assistant Secretary); Industries and Manufactures, Mr. P. W. L. Ashley, C.B. (Assistant Secretary); Industrial Property (including Patent Office), Mr. W. Temple Franks, C.B. (Comptroller-General); Power, Transport and Economic, Mr. H. F. Carlill (Assistant Secretary); Bankruptcy, Mr. J. G. Willis, C.B. (Inspector-General); Companies, Mr. H. M. Winearls, O.B.E. (Comptroller); Statistics, Mr. A. W. Flux (Assistant Secretary).

In addition, there are four general departments which deal with the Solicitor's, Finance and Establishment Departments respectively, and the "Board of Trade Journal," of which Mr. Harcourt Kitchen is editor. A Secretariat is also in process of formation, of which Mr. E. R. Eddison is the director, and the function of which is to provide the necessary working machinery for the Board of Trade Council to maintain proper liaison between the various departments.

There are five temporary departments, including the Profiteering Act dept., Capt. H. Hincks (Controller); Exports Credit Dept., Mr. L. A. Davis (manager); and the Clearing Office for Enemy Debts, Mr. E. Spencer Grey (Controller); and a reparation Claims department is being established, of which Mr. W. Neill will be the Controller.

The Department of Overseas Trade is under the joint control of the Foreign Office and the Board of Trade, its Parliamentary head being Lt.-Col. Sir Hamar Greenwood, Bart., K.C., M.P., and its permanent head Sir W. H. Clark, K.C.S.I., C.M.G. (Comptroller-General). The principal sections of the Department are: the Foreign, the Empire, the United Kingdom and the Exhibitions Divisions, with the Overseas Services and Home Establishment Branch. Sir F. G. A. Butler, K.C.M.G., C.B., acts as Director of the Overseas Divisions

The Board of Trade are at present responsible for the organisation of the Coal Mines Department, and there are few connected with the electric supply industry who do not credit them with the muddle they have created. The President of the Board has also established an internal Administrative Council which meets frequently to deal with current business involving questions of policy. The members of this Council (in addition to the President, who takes the Chair) include Sir H. Llewellyn Smith, G.C.B., Economic Adviser to H.M. Government (Vice-president of the Council); Mr. W. C. Bridgeman, M.P. (Parliamentary Secretary); Lt.-Col. Sir Hamar Greenwood, Bart., K.C., M.P., the permanent and assistant secretaries. The secretary to the Council is Mr. E. R. Eddison

In connection with the reorganisation of the Board, there is an interesting and highly instructive article in the current issue of our contemporary "Ways and Means" on the growth of Government expenditure which will well repay perusal by our readers.

Electricity Supply.

Lancaster Electricity Committee has authorised a demobilised officer to learn the duties of a switchboard attendant.

Nantwich Rural Council has consented to Crewe Corporation giving a supply of electricity for lighting the municipal houses which are to be built in the rural area.

Mr. J. Hutchings, architect to the Staffordshire Education Authority, is arranging for an electric light installation at the Farm Hostel and Dairy at Rodbaston, near Penkridge. The cost is estimated at £6,291.

Mr. Chas. Furness, borough Electrical Engineer and Manager at Blackpool, reports that the 10s. coal rebate, which will be passed on to the domestic consumers of electricity, will represent about ¼d. per unit.

As arrangements have been made by Dewsbury Corporation for a supply of electricity in bulk from the Yorkshire Electric Power Company, application has been made for sanction to a loan of £8,500 for sub-station plant and cables.

Newport (Mon.) Electricity and Tramways Committee recommend that the salaries of Mr. A. Nichols Moore, borough electrical engineer, and Mr. N. J. Young, tramways manager, be increased to £800 as from Jan. 1 last; to £850 on April 1; and to £900 in January next.

Burnley Electricity Committee recommended that the salary of Mr. J. E. Starkie, the borough electrical engineer, be increased from £672 16s. (including £72 16s. bonus) to £800 per annum, and that of Mr. T. B. Nutter, chief assistant, from £330 to £360 per annum.

Luton Corporation have decided to expend over £20,600 on new feeders and cables. Negotiations are proceeding with Harpenden Urban Council for a supply of electricity from Luton, although the North Metropolitan Electric Power Supply Company has statutory authority for Harpenden.

There is an increasing demand for electrical energy in Leeds for power and lighting and the Electrical Committee is considering a big scheme of extensions. The existing station in Whitehall-road is taxed to its utmost capacity and some applicants are unable to obtain electrical energy at present.

Blackburn Corporation is applying for sanction to borrow £130,000 for laying additional mains for the supply of electricity for power and lighting, including supplies to Rishton, Great Harwood, Mill Hill, the Workhouse and three housing schemes, together with provision, for power consumers and future extensions.

The estimates of the Sunderland Electricity Committee for the year ending March 31 next put the income at £134,334, compared with £102,859 last year, and expenses at £89,678, leaving £44,656, which it is proposed to distribute (after repayment of sinking fund, interest, &c.) as follows: Depreciation on mains, cables, switch-boards, &c., £5,186; outstanding balance on superseded plant £5,768.

Various extensions of the generating plant and mains are recommended by the Edinburgh Electric Lighting Committee, including two additional boilers for Dewar-place station at a cost of £2,300 and a 2,500-kw. turbo-alternator for M'Donald-road station at £20,000. It is also proposed to lay additional feeder cables in the outlying districts of the city, to purchase a motor convertor for Dewar-place station, to make structural alterations in the boiler-house at M'Donald-road at a total cost of over £60,000.

At the meeting of Colne Town Council last week a report was presented by the deputation which waited upon Sir John Snell, chief electricity commissioner, regarding the position of the electricity undertaking. Sir John sanctioned the installation of a turbo-alternator and an additional water-tube boiler to provide for next winter's demand on the understanding that arrangements for inter-connection between Nelson and Colne were still to hold good. A sub-station is to be erected in Dockray-street, and application is to be made for a loan of £20,000.

Steady progress is being made with the formation of the District Industrial Councils for the electricity supply industry. At a conference held at Portsmouth last week a District Council was formed for the South Eastern Area, which includes the municipal undertakings in Portsmouth, Basingstoke, Bexhill, Brighton, Eastbourne, Fareham, Horsham, Hastings, Hove, Southampton, Weymouth, Winchester and Worthing, as well as representatives from electricity supply companies in Dorset, Bournemouth, Lewes, Leamington, Isle of Wight and other places.

For the purpose of giving a supply of electricity to the houses in course of erection at Woodside the Croydon Lighting and Electricity Committee propose to lay distributors to the district at a cost of £1,560, of which £1,125 will be the cost to the estate. The Committee has under consideration the method by which the current supplied is to be paid for by the tenants.

The Committee will co-operate in the formation of a Joint Electricity authority for the Greater London area.

The Birmingham Electric Supply Committee report that the rebate to electricity consumers, consequent on the reduction of 10s. per ton in the price of coal used for domestic purposes, and which will be given by way of allowance on the March quarter's accounts, will be probably less than ¼d. per unit. A general increase in the rates charged to consumers is not contemplated at present, notwithstanding wages advances, increased railway freights, &c. Mr. Beale, the chairman, states that the demand for current is increasing very rapidly, and the persons now asking for power supply would entirely absorb the amount that could be generated at the new station at Nechells when the authorised extensions were completed.

Electric Traction.

Lancaster Corporation have appointed Mr. Arthur R. Fearnley, general manager of Sheffield Corporation Tramways, at a fee of 110 guineas, to prepare a report on the question of mechanical traction.

Padiham Council is sending a deputation to Burnley Tramways Committee to discuss the question of the lease of the tramway lines in Padiham area, which expires at the end of 1922.

Burnley Town Council has increased the salary of the Tramways Manager (Mr. H. Mozley) from £500 plus £75 war bonus per annum to £675 per annum including bonus, and payable as from Jan. 1.

The Promenade is the most profitable of Blackpool's tramways. During the last financial year the percentage of receipts to the total on this section was 30·92. Squire's Gate came next with 24·58; Marton next with 15·86; and New-road last with 6·28. The receipts per car-mile on the Promenade were nearly 3s., but those on the Circular Tour were over 3s. 7½d.

Sheffield Tramways Committee is again faced with a demand for increased wages. In October last the men applied for 12s. advance, but on arbitration, only 4s. was granted. The men now demand another 10s. a week for adults and 5s. for juniors. The motor man's minimum rate is 1s. 4½d. per hour, and that of the conductor 1s. 3¼d. per hour, or £3 6s. and £3 1s. per week respectively. The new application will come before the National Joint Industrial Council this month.

At the instance of the London County Council a conference was recently held at the County Hall on the subject of the maintenance of the roadways in thoroughfares where tramways are laid. A resolution was passed expressing sympathy with the desire of the L.C.C. to relieve the Tramway Undertaking of the Financial Burden connected with the maintenance of the roadways in which tramways are operated, but as the proposals put forward were not acceptable to the Metropolitan Borough Councils the L.C.C. was asked to take the matter into consideration once more, with a view to their seeking relief by endeavouring to secure a larger portion of the proceeds of the petrol tax. It was considered that the cost of the maintenance of main roads should be a charge upon the State.

Imperial and Foreign Notes.

The report of the Southern Canada Power Company for the year ended Sept. 30, 1919, states that the new power development at Drummondville is now in successful operation. Including subsidiaries, the year's gross earnings were £566,091, against $475,009 for previous year; profits $263,293, against $210,517; interest, &c., $205,229, against $162,359; surplus for year $58,064, against $48,157.

The Minister in charge of the Tasmanian State Hydro-Electric Department recently submitted to Parliament proposals for the extension of the hydro-electric works. The capital expended to date is £776,778, and £558,000 will be voted this year for the further development of the great Lake works. This will provide about 70,000 H.P., of which 57,200 H.P. will be distributed as follows:—30,000 H.P. to the Electrolytic Zinc Company for the production of zinc from New South Wales ores and for use in its subsidiary industries; 10,000 H.P. power to the Hydro-Electric Power and Metallurgical Company for the manufacture of carbide; 6,000 H.P. Hobart and suburbs and 3,000 H.P. to Launceston, leaving 8,200 H.P. to meet new demands during the next two or three years.

The question of adoption electric traction is also engaging the attention of the Tasmanian Government. It was proposed to build a railway from Hobart to the Huon, and the Government submitted a vote of £4,000 for the survey of a route for a "steam or electric" railway, but the vote was only passed on condition that the survey was for an electric railway.

The Nordmark Klaraelven (Sweden) Railway Company is issuing Kr. 4,000,000 (in bonds of Kr. 1,000 and Kr. 5,000) at 6 per cent. interest. Reuter states that the funds are required mainly for the electrification of the railway.

According to a "Daily Express" correspondent French and Italian engineers have arrived at Chamonix in order to make surveys in connection with the proposed tunnel beneath Mont Blanc, with a double line of electric railway, which will join France and Italy direct. The two Governments have voted a joint sum of £5,000,000 for the project. France has contributed £1,800,000 and Italy £1,600,000 for preliminary expenses.

There appears a good deal of activity in electrical circles in Italy, but more particularly in connection with hydro-electric work. The Società Generale Elettrica della Sicilia, of Milan, recently decided to increase its share capital from 32,000,000 lire to 50,000,000 lire by the creation of 180,000 new shares of 100 lire each; and the shareholders of the Società Italiana di Elettrochemica, of Rome, have authorised the increase of the capital from 10,500,000 lire to 24,500,000 lire.

Owing to the difficulty of importing coal various Swiss hydro-electric schemes have recently been projected, and one of the most important of these is that of the Forces Motrices Bernoises, which proposes to generate 210,000 h.p. in the Oberhasli Valley (Bernese Oberland). "The Times" states that a large dam has been erected at the foot of the Bächli Glacier, near the Juchlistock. From the slopes of the Nägelis Grätli (above the Rhône Glacier) to the Unteraar Glacier there will be a lake over three miles in length, taking in the two present lakes. The Gelmersee also will have its dam, which will quadruple its area. There will be two power stations, one at Guttannen and one at Innertkirchen, but all tubes and pipes will be underground. The total cost of the scheme is estimated at about £4,000,000, and it is hoped that the work will be completed within six years.

Institution Notes.

Institution of Electrical Engineers.—A sub-centre of the Institution has been formed in the East Midlands, with headquarters at Loughborough, the chairman for the present year being Mr. F. S. Grogan. The inaugural meeting was held on Tuesday last, the 3rd inst., when an address was delivered by the chairman, who mentioned that the meetings would not be held solely at Loughborough, but also at other centres in the area. The membership now was 104 (27 from Loughborough, 27 from Derby and 24 from Nottingham). Mr. Grogan then delivered his address, which was on the electrical engineer, his training, work and status.

In a new publication of the Bureau of Standards, Washington, Scientific Paper No. 352 on "Thermal Expansion of Insulating Materials" data are given on the thermal expansion of some of the more important insulating materials. In most cases the expansions are too irregular to justify the use of the general quadratic equations. A knowledge of the thermal behaviour of these materials is essential before assembling them in certain types of apparatus subjected to wide temperature variations. The most striking peculiarities are: (*a*) The wide range in the values of the coefficients of porcelain from 1·6 to 19·6 millionths per unit length per degree centigrade, (*b*) The three varieties of expansions for porcelain, namely, straight line, concave and convex expansion curves, (*c*(The shrinkage and the loss in weight of the phenol and similar compounds when subjected to excessive heat treatment, (*d*) The permanent growth and variations of different marbles when subjected to heat treatment, and (*e*) The negative coefficient of expansion of marble at low temperatures. Interested readers may obtain a copy from this bureau.

There was some criticism of the existing Home Office Rules for the use of electricity in Mines at the recent meeting of the Midland branch of the Association of Mining Electrical Engineers at Nottingham. Mr. A. W. Williams referred to the vagueness of some of the rules which created a rather complicated position. All apparatus should not only be made to conform with certain specifications, but they should also, before being used in mines, be certified, and a certificate should be secured by the manufacturers from a Government Department. When apparatus, which had been certified, had been erected, a certificate, if approved, should then be given after test and inspection that such apparatus, if maintained in its present condition, complied with the regulations of the Home Office. The tests would involve a number of inspectors, but if competent electrical inspectors with a good experience of colliery work, were employed their work would justify the additional expenditure.

A resolution was passed recommending the General Council of the Association to call the attention of the Home Office to the need of revising certain rules to make them clear and definite.

Paris Academy of Sciences.—Among the prize awards of the Paris Academy of Sciences for the year 1919 are the following:—The Kastner-Boursalt prize to Marius Latour, for his researches on electric motors; the Gaston Planté prize to Emile Brylinski, for his work in applied electricity; the Hébert prize to Raymond Jouaust, for his work on magnetism, electrical standards, photometry and wireless telegraphy; the De Parville prize to Louis Décombe for his work in various branches of physics; the Hughes prize to Henri Chaumat, for his work on the industrial production of ozone, the electrolytic reduction of indigo and other dyes, and other work in electrotechnics; the Pierson-Perrin prize to Georges Sagnac, for his work on the secondary X-Rays, interference and other optical phenomena; the Clément Félix foundation to Charles Féry, to enable him to continue his experiments on the production of a small dry accumulator: and the Henry Wilde prize between Jean Rey (1,000 francs), for his researches on projectors, and Adrien Bochet (1,000 francs), for his mechanical and optical inventions.

Telegraph and Telephone Notes.

Since Dec. 1, when the direct Swedish-German Telephone Line was opened, 2,390 calls have been recorded from Sweden, and nearly the same number in the opposite direction.

Bolton Corporation object to the proposal of the Postmaster-General to equip a new manual telephone exchange at Bolton next year rather than an automatic exchange. The reason alleged for this step is that the cost of automatic equipment is prohibitive, and a deputation is to wait upon the Postmaster-General on the matter.

The Scandinavian Shipowners' Associations recently asked for a modification of or a postponement of the time limit for enforcing the regulations as to wireless installations on ships of over 1,600 tons, but the Foreign Office, while refusing to accede to the demand, suggest that if the Swedish Government send technical representatives they will receive all the information possible. The new regulations will come into force in December, 1920

The Fiftieth Anniversary of the Transfer of the Telegraphs from private ownership to the Postmaster-General was celebrated yesterday. From the "Manchester Guardian" we learn that at the date of the transfer there were only 1,000 telegraph offices, with 1,800 offices at railway stations, and the charge was 1s. for 20 words, covering delivery within 1 mile, with 6d. per mile for porterage beyond that limit. The reduction in the tariff in 1885 to 6d. for 12 words led to a great increase in the traffic, and there are now 33,000 registered telegraphic addresses in London alone. Among the many striking developments that have taken place are the use of printing and multiplex machines and the introduction of wireless telegraphy.

Miscellaneous.

The Senate of the University of London have expressed their appreciation of the generosity of Messrs. S. B. and J. B. Joel in presenting £20,000 for the endowment of a University Chair of Physics, tenable at the Middlesex Hospital Medical School.

An inquest was held at Wakefield on Friday on William Henry Riley, a railway goods guard of the Lancashire and Yorkshire Railway Company, who received a fatal electric shock from a fallen telephone wire which had passed over the wires of the tramway company on the 29th ult. The coroner said, there was the question why the telephone wires were not insulated and why the tramway wires were not protected. He thought it would be better to communicate with the Board of Trade or the Home Office, with a view to having an inspector present at the inquest, which he adjourned until the 10th inst.

Some statistics of strikes appear in the last issue of "The Employer." From Jan. 1 to Nov. 30, 1919, the official figures of the loss of working days from strikes reach the stupendous aggregate of 32,769,000, and if we add to these figures the unemployment caused to workers in other trades by the nine days' railway strike, the engineering strike, the Yorkshire miners' strike, the ironmoulders' and other strikes, the total does not fall short of 40,000,000. The chief trades affected are textiles 8,163,000 days, engineering and shipbuilding 8,134,000, coal mining 7,406,000, and transport 3,868,000 days.

The President of the Board of Trade has appointed a Committee under the Chairmanship of Mr. Clifford C. Paterson, O.B.E., M.Inst.C.E., M.I.E.E., to consider whether, in order to secure that Ships' Lights shall comply with the requirements of the International Collision Regulations, it is desirable to lay down standards for the lights, or any parts of them; and, if so, to advise what those standards should be, and what is the best method of securing compliance with them. Mr. J. W. T. Walsh, of the National Physical Laboratory, and Mr. A. S. Hoskin, of the Board of Trade, will act as Joint Secretaries to the Committee. Communications should be addressed to the Secretary, Ships' Lights Committee, Board of Trade, Great George-street, S.W. 1.

The Ministry of Health has issued regulations governing the payment of the new House Building Subsidy. The object of the subsidy, on which the expenditure of £15,000,000 for the United Kingdom is authorised, is to secure the erection of 100,000 houses during the next 12 months. The regulations indicate that the subsidy is only to be earned by houses completed within 12 months of Dec. 23, 1919, or within such further period, not exceeding four months in all, as the Minister may in a special case allow. In the case of houses completed within this longer period the Minister may subject the grant to a reduction of one-twelfth for each month in which delay has occurred. The subsidy is to be £160, £140 or £130 per house, according to the number of rooms and the extent of floor area. In calling upon the Ministry of Health to pay the grant the builder must be armed with a certificate by the local authority authorising the houses to be constructed and a certificate that they have been duly completed in a proper manner.

An important two-day National Conference of Manufacturers and Producers will be held at Kingsway Hall, London, W.C. 2, on the 10th and 11th inst. The chairman will be Mr. W. Peter Rylands, President of the Federation of British Industries, with Mr. E. Manville, M.P., as deputy chairman. All the important associations of manufacturers and producers are taking part, including the Association of British Chambers of Commerce, the National Confederation of Employers' Organisations, Coal Association, British Engineers' Association, National Federation of Iron and Steel Manufacturers, Glass Bottle Manufacturers' Association, Chemical Manufacturers' Association, British Empire Producers' Organisation, the big textile associations, &c. After the Chairman's opening address, the following subjects will be discussed on the first day: (1) Export Trade and Foreign Exchanges, (2) Prices and Profits, and (3) Government finance and expenditure. On the second day nationalisation, transport, fuel, education, research and housing will be dealt with.

Dinners and Socials.

The Cryolite Athletic Association (London Staff of the British Aluminium Company) added to its already enviable record of social functions by holding a most successful fancy dress dance at the Cannon-street Hotel on the 31st ult. Over 200 dancers, mostly in gay array, enjoyed a thoroughly merry evening. Mr. W. Murray Morrison (President of the Association) and Mrs. Morrison, Mr. A. W. Tait, C.B.E. (Chairman of the Company) and other notabilities in the aluminium world were present.

At the Connaught Rooms on the 21st ult., the senior members of the staff of Messrs. Waygood-Otis, Ltd., the lift makers, entertained the directors and two members of the staff (Mr. B. P. Walker and Mr. T. Simmons), who had just returned from a journey to the States. After the reception by the chairman (Mr. Geo. Martin) dinner was served. The toast of the guests was proposed by the Chairman, seconded by Mr. F. Colebrook, and Mr. Charles Clarke, one of the managing directors, replied. The toast of the company was given by Mr. H. Lambie, to which the chairman of the company (Mr. Henry Claude Walker) responded, and the other directors present, Messrs. D. W. R. Green (one of the managing directors), R. H. Thorpe, H. Harmsworth and C. H. J. Day, also spoke. A happy gathering concluded with the toast of the chairman, proposed by Mr. A. A. Williams, of Leeds, and received with musical honours.

Tenders Invited and Accepted.

King's Lynn Electricity Committee require tenders by noon Feb. 20 for the supply of one Lancashire boiler.

West Ham Corporation require tenders by 4 p.m. Feb. 24 for erection and supply of a refuse destructor and steam-raising plant Specifications from the Borough Engineer.

Manchester Electricity Committee require tenders by Feb. 25 for three three-wire balancers and switchgear. Specifications from Mr. F.E. Hughes, Town Hall, Manchester.

Manchester Tramways Committee want tenders by 10 a.m., Feb. 17, for steel girder tram rails, tramcar trucks and controllers. Specifications from the General Manager.

Manchester Corporation Waterworks Committee require tenders by Feb. 21 for an electrically-driven multi-stage centrifugal pump, with switch and controlling gears, &c. Specifications from the Secretary, Waterworks Offices, Town Hall, Manchester.

Sydney (N.S.W.) Council require tenders by 3 p.m., March 1, for the supply of two 2,000 p.v.a., 5,000-10,000 volt transformers (contract No. 571). Specifications from the City Electrical Engineer.

The Victorian Railway Commissioners, Melbourne, require tenders by March 31 for supply of metal filament and carbon filament lamps (contract 32,927).

The Commissioners of H.M. Works invite tenders (by 11 a.m., Feb. 13) for the supply of electric wire and cable. Tender forms from the Controller of Supplies, King Charles-street, London, S.W.1.

The Metropolitan Water Board require tenders by 11 a.m. on Feb. 20 for three, six or 12 months' supply of stores, including electric lamps, electric wire and accessories, oils, &c. Forms of tender from the Chief Engineer, South-place, Finsbury, London, E.C.2.

Belfast Tramways Committee require tenders by Feb. 14 for the supply of electrical accessories, copper strip, lamps, insulating tapes, carbon brushes, controller fingers, trolley wire, &c. Forms of tender from the General Manager, Napier-street, Sandy-row, Belfast.

The City of Melbourne invites tenders for the supply of 12,000 metal filament lamps. Specifications, &c., from the agents of the City Council, Messrs. McIlwraith, McEacharn & Company Ppty., Ltd., Billiter-square-buildings, London, E.C. 3, to whom tenders are to be sent by noon March 30.

Manchester Waterworks Committee require tenders by Feb. 21 for the supply and erection at Thirlmere of water turbine, dynamo, storage battery, booster, motor-generator, d.c. motors, starting panels and cables. Specifications from the Secretary, Water Department, Town Hall, Manchester.

Palmerston North (New Zealand) Council require tenders by 4 p.m. March 2 for the supply of two 400 h.p. pressure producers and auxiliaries, 3,000-volt generating sets, converters, battery switchboards, &c. Specifications can be inspected at the Department of Overseas Trade (Room 40), 35, Old Queen-street, London, S.W.1.

The Ministry of Communications (Director of Telegraphs and Telephones), Athens, require tenders by May 13 for supply of wooden poles, galvanised and brass wire, insulators, telephone cables, exchange equipment, &c. Specifications from the Ministry of Communications, Athens.

The Electrical Committee of Bristol Corporation invite tenders for the supply and erection of one 2,000-kw. single-phase 2,200 volt turbo-generator, with condenser and auxiliaries. Specifications and forms of tender from the chief engineer and general manager, Mr. H. Faraday Proctor, M.I.C.E., The Exchange, Corn-street, Bristol, to whom tenders must be delivered by the 23rd inst.

Aldershot Urban Council invite tenders for geared turbine and generator, condensing plant, circulating and other pumps, water-tube boiler and super-heater, and armoured, lead-covered, paper-insulated feeder and pilot cables. Particulars from the electrical engineer, Mr. F. Garside, and tenders to the clerk to the council, Mr. D. Llewellyn Griffiths, Municipal-buildings, Grosvenor-road, Aldershot, by Feb. 17.

Tenders are invited for the supply and delivery in Melbourne of two 2,000-kw. rotary converters and h.-t. and d.-c. switchgear. Specifications, &c., may be obtained from the Agents of the City Council, Messrs. McIlwraith, McEacharn & Company Proprietary, Ltd., Billiter-square-buildings, London, E.C. 3. Tenders to the Town Clerk, Town Hall, Melbourne, by 2 p.m. April 12.

Lincoln Corporation invite tenders for the supply and erection of an accumulator battery at St. Swithin's power station. Specifications from the consulting engineers (Messrs. Preece, Cardew & Rider), 8, Queen Anne's-gate, Westminster, S.W.1; and copies of the specifications can also be seen at the office of the city electrical engineer, Mr. Stanley Clegg. Tenders, on forms to be obtained from the Town Clerk's office, Guildhall, Lincoln, by March 2.

Colne Council has placed an order with the Stirling Boiler Company for a water-tube boiler, steam pipes and feed pump at £4,443; while a 2,000-kw. turbo-alternator is to be purchased from Stockport Corporation for £10,000.

Bradford Tramways Committee has accepted the under-mentioned tenders:—English Electric Company, 87 standard tramcar trucks, £19,140; 124 electrical tramcar equipments, £43,059; 20 tramcar bodies, £29,300. The Electricity Committee has placed the following orders:—Ferranti Ltd., three 150 and two 600 k.v.a. transformers; Brush Electrical Engineering Company, three 250 k.v.a. transformers, and British Electrical Transformer Company, two 100 k.v.a. transformers A. Reyrolle & Company, Ltd., a.-c. switchgear..

Rawtenstall Corporation has accepted the following tenders:—British Thomson-Houston Company, 5,000kw. turbo-alternator; Hicks, Hargreaves & Company, condenser; Babcock & Wilcox, two watertube boilers; induced draught plant, coal bunkers and conveyors; G. & J. Weir, feed pump; and Metropolitan-Vickers, Electrical Company, 500kw. rotary converter.

Barnsley Electricity Committee has accepted the following tenders: Ferguson, Pailin, Ltd., h.-t. switchgear, £292; British Insulated & Helsby Cables, Ltd., l.-t. cable, £595; English Electric Company, 1,300-kw. turbo-alternator, condensing plant, air filter, &c., £23,879; Babcock & Wilcox, water tube boiler, stoker, economiser and induced draught fan, £8,515; Mather & Platt, turbine boiler feed pump, £446.

Hammersmith (London) Borough Council has accepted tenders for the supply of refractory bricks and blocks, ground fire clay and other building materials required for the provision of a new boiler. The contract for sections A and B has been given to Messrs. Hill, Westlake & Company, at £652 5s.; for section C to the Metallurgical Plant Construction Company (£213 11s. 1d.) and for section D to Messrs. J. H. Sankey & Son (£113 15s.).

In connection with the various extensions of mains which have been recently sanctioned by the Council the tender of the Union Cable Company (at £1,800) has been accepted, subject to samples being to the satisfaction of the Borough Electrical Engineer. Eleven tenders were received, varying from £1,800 to £2,027. The tenders of Messrs. Thomas Wragg & Son for the supply of cable ducts (at £419 15s. 10d.) has also been accepted.

In connection with the scheme for linking-up the Battersea, Fulham and Hammersmith generating stations ten firms submitted schemes for the work of linking-up the stations of Fulham and Hammersmith. Nine firms submitted three schemes each, and the tenth (Messrs. W. T. Glover & Company) two. The borough electrical engineers, who considered the tenders, recommended for acceptance the tender of W. T. Henley's Telegraph Works Company for scheme C at £15,905 0s. 1d., and both Councils have accepted the recommendation.

Catalogues, Price Lists, &c.

In the illustrated price list issued by Messrs. H. T. Boothroyd, Ltd., of Bootle, the dimensions, outputs and prices are given of direct-current motors and dynamos, electric lighting sets, &c., manufactured by them.

Illustrated particulars of the design and construction of the "Prescot" mistake-proof switch cut-outs are given in pamphlet No. P.162, recently issued by the British Insulated & Helsby Cables, Ltd., of Prescot. All live parts are adequately protected, so that when the hinged cover of the fuse chamber is open they cannot be touched.

We have received from Micanite & Insulators, Company Ltd., a copy of their 1920 descriptive catalogue on standard insulating materials. This covers the whole range of insulating materials made by them and gives adequate details of their various properties. In addition, the same Company have issued a very useful sample book which contains, in the same way as a tailor's samples, strips of the various insulating materials made by the firm. The quality and appearance of the material is therefore easily gauged and the book should be extremely useful to those whose business it is to bring the various sorts of insulating material before buyers.

The Wireless Speciality Apparatus Company, of Boston, Mass., has recently issued a well-illustrated catalogue of 84 pages, which gives details of the radio equipment supplied by the company. Particulars are given of transmitters, receivers, crystal detectors, Eaton circuit devices, transformers, keys, Faradon mica condensers, storage batteries, &c. A section is devoted to a description of the patented contributions to the art by the company, and to photographs of the company's shops and installations. There are also eleven pages of formulæ for the calculation of radio phenomena.

Messrs. Ferranti Ltd., of Hollinwood, Lancs., have issued an abridged catalogue of their manufactures for Continental propaganda work. The catalogue, which contains prices and weights of all their specialities (house service meters, switchboard instruments and static transformers) is clearly illustrated and nicely printed, and is issued in six editions in English in French, Italian, Spanish, Portuguese and Danish. In addition, a Dutch edition, which is in the Press, will be issued shortly. As the prices and weights are given in the metric system Continental engineers can readily understand what the company can supply. We commend the enterprise of Messrs. Ferranti, who appear to understand the correct method of reaching Continental buyers.

Measurement of water over weirs and V. notches is the subject of a special technical booklet for issue to Civil Engineers, &c., which we have received from The Lea Recorder Company, Ltd., 28, Deansgate, Manchester. Within a small space most of the essential technical data on the subject are given, and the pamphlet is copiously illustrated and provided with diagrams. Measurement of streams and rivers, supplies to reservoirs, mine water and pump discharges, &c., are dealt with, and special interest will probably attach to the formulæ resulting from recent investigations, and to the tables of flows with their accompanying formulæ. Some good illustrations of actual machines at work are given, together with the different types of instruments applicable to various situations. The company have also issued two leaflets on the "Lea" recorder system of continuous testing for boilers, engines and turbines, and on "Lea" V. notch and weir recorders for measuring water supply, &c.

Personal and Appointments.

Dr. Samuel Smiles, D.Sc., F.R.S., has been appointed to the Daniell Chair of Chemistry at King's College, London.

We regret to learn that owing to ill-health Mr. R. H. Piper has resigned his position as secretary of the Guildford Electricity Company, Ltd.

Colonel Hubert C. Sparks, C.M.G., D.S.O., M.C., M.I.E.E., M.I.Mech.E., has been appointed a Governor of Faraday House Engineering College. He was a student of the College from 1891-1892.

Walsall Education Committee have appointed Mr. J. A. Doran, of London, engineer instructor at the Municipal Institute at a salary of £300 per annum.

It is proposed to commemorate the splendid national work performed by Sir Richard Glazebrook, K.C.B., during the 19 years he held the position of Director of the National Physical Laboratory. In order to place in the laboratory a plaque designed by a leading artist, a fund of about 200 guineas is being raised, and subscriptions, limited to two guineas, will be received by Dr. E. H. Griffiths at Cambridge.

Mr. S. Springer, who has been the head of the overseas organisation of the Federation of British Industries, has been appointed an Assistant Director of the Federation. The following further overseas trade representatives have been made by the Executive Committee of the Federation: Mr. G. C. Musgrave as a representative of the Federation in Cuba, and Mr. Antonio Gibbon to Mexico (7a, Naranja 179, Mexico.

Mr. Eric Jones, B.Sc., Assistant Lecturer in the Department of Engineering of the University College of S. Wales and Monmouthshire, is leaving to join the staff of the Department of Engineering of Owens College, Manchester. On the 28th ult. the Engineering Society of the University College of S. Wales and Monmouthshire (recently constituted an Association of Students of the South Wales Institute of Engineers) held a smoking concert, which was presided over by Prof. F. Bacon, M.A., M.I.E.E., when Mr. Jones was presented with a handsome clock and a pipe. Mr. Jones will be succeeded at the University College, Cardiff, by Mr. C. V. Miller, B.Sc., from the R.A.E., Farnborough.

Mr. Edward D. Kilburn, who since March 15, 1917, has been New York District Manager of the Westinghouse Electric and Manufacturing Company, was recently elected Vice-President and General Manager of the Westinghouse Electric International Company. Mr. Maurice Coster, who has been actively engaged for more than 30 years in handling the foreign interests of the Westinghouse Company continues Vice-President of the International Company with advisory duties. The president of the International Company is Mr. Loyall A. Osborne, senior vice-president of the Electric Company. The International Company, which was formed in the spring of 1919 to succeed the Westinghouse Electric Export Company, handles the Westinghouse foreign business.

Appointments Vacant.

A switchboard attendant is required by Blackburn Corporation Electricity Department. Applications by Feb. 16 to Mr. P. P. Wheelwright, borough electrical engineer.

An assistant lecturer and demonstrator in electrical engineering is required for Sheffield University. Salary £300. Application to the Dean of the Faculty of Engineering.

The Ministry of Munitions requires instructors in electrical and mechanical engineering, applied chemistry, preliminary technical courses, &c for convalescent centres. Applications to the Secretary of the Ministry, Treatment Training Branch, Smith-square, London, S.W.1, by Feb. 9

Business Items, &c.

The partnership between Wm. Jas. R. Fox, Geo. L. Brown and Herbert C. Jones (trading as the Park Electrical Engineering Company), Westinghouse-road, Trafford Park, Manchester, has been dissolved. Debts by Messrs. G. L. Brown and H. C. Jones.

Mr. Robt. H. Ruddock will sell by auction on the 12th inst. at the Kingsbury Engineering Works, Kingsbury, N.17., a number of machine tools and lathes, welding plant, two biplanes with engines, aeroplane constructional materials, &c.

The Arora Company, of Loughborough, announce that in consequence of the greatly increasing business in Electric Fires their sales have again doubled this year, and had it not been for the moulders' strike of 18 weeks they would have been trebled. The Company are continually appointing new agents in the various territories. The present agents are as follows:—London, Millns Electrical Company, 17, Whitefriars-street, E.C. 4; Manchester, J. C. White, A.M.I.E.E., 1, Cumberland-street, Deansgate; Liverpool, W. H. Walton, A.M.I.E.E., 38/44, Beau-street; Bradford, J. Dyson, 7/9, Aldermanbury; Newcastle-on-Tyne, T. J. Grainger & Company, 31, The Side; Birmingham, The Priory Engineering Company, Bath-street; Scotland, A. Watson & Company, Whiteinch, Glasgow.

Liquidations and Bankruptcies.

Claims against the New St. Helens and District Tramways Company, Ltd. (in vol. liq.) are to be sent by Feb. 28 to Messrs. H. P. Conibear and E. H. Edwards, Generating Station, Home Bridge, Atherton, Lancs.

A first and final dividend of 3s. will be payable on Feb. 16 at 132, York-road, London, S.E.1, to creditors of Cecil Hellyar (trading as A. Parker & Company), electrical engineer and contractor, East Sheen.

Companies' Reports, &c.

Lieut.-Col. Sir Harry C. W. Verney, Bart., has been elected a director of the Metropolitan Railway Company in succession to Mr. A. G. Kitching deceased.

The Smithfield Markets Electric Supply Company, Ltd., has declared a dividend of 2 per cent. (2s. per share) on the ordinary shares or the past year, carrying forward about £1,300.

The directors of the Westminster Electric Supply Corporation, Ltd., recommend a dividend for the past half-year at the rate of 13 per cent. per annum, less tax, making 10 per cent. for the year, compared with 8 per cent. for 1918.

The accounts of the Blackpool, St. Anne's and Lytham Tramways Company, Ltd., for the year to 31st October show a profit of £10,093. There is a debit balance (after providing for debenture interest and sinking fund), of £37,991.

The directors of the Tottenham District Light, Heat & Power Company have declared dividends for the half-year ended Dec. 31 at the rate of $3\frac{3}{4}$ per cent. per annum on the "A" stock, and at rate of $2\frac{5}{8}$ per cent. per annum on the "B" stock. The amount to be carried forward is £7,152, compared with £4,169.

The directors of the St. James' & Pall Mall Electric Light Company, Ltd., recommend a balance dividend on the 7 per cent. preference shares for the half-year ended Dec. 31, 1919, of 3s. 6d. per share, and 8s. 6d. per share on the ordinary shares, making, with the interim dividend paid thereon, a total distribution of 12 per cent. for the year, compared with 10 per cent. in 1918.

The total net income of the London, Brighton and South Coast Railway Company for 1919 amounted to £1,538,429 (against £1,527,114) and with £25,884 brought forward the total is £1,564,313. Further dividends of £4 per cent. on the undivided ordinary stock, making $5\frac{1}{4}$ per cent. for the year, £3 10s. per cent. on the preferred ordinary, making 6 per cent. and £4 10s. per cent. on the deferred ordinary, are declared as in 1918, leaving to be carried forward £32,890.

The directors of the Eastern Telegraph Company, Ltd., have decided to pay in May next a final dividend for the year ended Dec. 31, 1919, of $5\frac{1}{2}$ per cent., making 10 per cent. for the year, tax free, paying no bonus. They have also decided to issue £1,000,000 ordinary stock to meet expenditure which is being incurred to add to and improve the cable services. The stock will be offered at par to holders of ordinary stock, and after the necessary powers have been obtained from the stockholders to increase the capital, the prospectus will be issued.

The directors of the Eastern Extension Australasia and China Telegraph Company, Ltd., will pay in May next a final dividend for the year ending Dec. 31, 1919, of $5\frac{1}{2}$ per cent., making 10 per cent. for the year, tax free, paying no bonus. They have also decided to issue 100,000 shares to meet expenditure for adding to and improving the cable services. These shares will be offered at par to the shareholders. After the necessary powers have been obtained to increase the capital the prospectus will be issued.

The directors of the Western Telegraph Company, Ltd., have decided to pay in March next a dividend of $2\frac{1}{2}$ per cent., and in the subsequent quarter a similar dividend, the intention being to pay a final dividend of $3\frac{1}{2}$ per cent., making with the dividend paid in December last 10 per cent., tax free, for the year, paying no bonus. They have also decided to issue 100,000 ordinary shares to meet expenditure which is being incurred to add to and improve the cable services. The shares will be offered at par to the shareholders. After the necessary powers have been obtained from the shareholders to increase the capital the prospectus will be issued.

The profit of the Llandudno & Colwyn Bay Electric Railway, Ltd., for the year Nov. 30 last, after providing for costs of operation and administration, and for interest on debenture stock and loans, was £5,196, and with £387 brought forward, the available balance is £5,583. Of this amount £1,860 has been applied to sinking fund, leaving £3,723. The directors recommend payment of a dividend at the rate of 4 per cent. per annum (£2,783), leaving to be carried forward £940. There have been heavy increases in operating and maintenance charges, the former being due to additions of pay, and the latter to exceptional expenditure upon repairs to and renewals of rolling stock and permanent way. In accordance with existing practice, the sinking fund instalment has been charged against revenue, and no further provision has been made for depreciation. Owing to ill-health, Mr. T. Stoker, C.S.I., has been compelled to resigned from the board.

New Companies.

AUTOMOBILE ELECTRICAL REPAIRERS, LTD. (162,841).—Private company. Reg. Jan. 15, capital £1,000 in £1 shares, to carry on the business of electrical and mechanical engineers, &c. First directors are P. Goldstein and C. F. Collins. Reg. office: 400, Euston-road, N.W.

BRITISH EAST AFRICA POWER DEVELOPMENT COMPANY, LTD. (163,345).—Private company. Reg. Jan. 27, capital £1,000 in £10 shares. The company is formed as a subsidiary company to the British Water Power Development Company, Ltd., to acquire, and if necessary extend the Thika Sidal Hydro Electric Plant; and the Head Works and rights of Messrs. Swift, Rutherford & Company on the Maragua River, in Fort Hall District, British East Africa; to acquire all present and future rights for the supply of hydro-electric power in British East Africa, &c. The first directors are: D. Spencer, R. H. Mackenzie and W. F. Harwar. Reg. office: 41, Parliament-street, S.W.1.

OLIVER ENGINEERING COMPANY, LTD. (162,770).—Private company. Reg. Jan. 13, capital £2,000 in £1 shares, to take over the business of mechanical and electrical engineers and general metal workers carried on as Oliver & Dunbabin. First directors are A. H. Oliver, J. Sulch, F. Lavy and J. O. Dunbabin. Reg. office: 9, Fenchurch-street, E.C.

PORTADOWN ELECTRIC COMPANY, LTD. (1,871)—Private company. Reg. in Dublin Jan. 8, capital £20,000 in £1 shares (5,000 preference), to produce, store, supply and sell electrical energy, &c. First directors are M. Curran and D. Chapman. Reg. office: 7-8, Market-street, Portadown, co. Armagh.

PORTUMNA ELECTRIC LIGHT & POWER COMPANY, LTD. (4,874) Reg. in Dublin on Jan. 12, capital £5,000 in £1 shares, to carry on in Portumna and elsewhere the business of an electric light company. The directors are Viscount Lascelles, A. E. Moeran, Mrs. M. M. Nolan, J. Hynes, N. J. Kelly, J. Corcoran, G. J. Coates, J. Taylor and J. Murphy. Secretary: M. C. Woulfe. Reg. office: New-street, Portumna, county Galway.

POURLOCK COMPANY, LTD. (162,547)—Private company. Reg. Jan. 7, capital £50,000 in £1 shares, to take over the British and certain foreign patent rights relating to an invention for differential gearing, to adopt an agreement with R. A. Rothermal and C. A. Vandervell, and to carry on the business of manufacturers and repairers of and dealers in gearings, machinery, automobiles, &c. R. A. Rothermal is the first director. Reg. office: 24-6, Maddox-street, W.1.

POWER-RECTIFIERS, LTD. (163,400).—Private company. Reg. Jan. 28, capital £20,000 in £1 shares, to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in transformers, mercury-arc rectifiers, accessories appertaining thereto, &c. First directors are: G. Boner, Baden, Switzerland, manufacturer, and A. C. Eborall (managing director), 9, Old Queen-street, S.W.

ROADCRAFT, LTD. (162,825).—Private company. Reg. Jan. 14, capital £5,000 in £1 shares. Objects: to take over the business carried on at 89, Cheapside, Liverpool, as the Roadcraft Engineering Company, and to carry on the business of mechanical, electrical and civil engineers, manufacturers of motor cars, &c. First directors are W. B. Douglas, T. R. Walls, G. W. Oates and H. J. Carey. Secretary, J. E. Smith.

STAFFORDSHIRE ELECTRICAL ACCESSORIES COMPANY, LTD. (163,356).—Private company. Reg. Jan. 27, capital £6,000 in £1 shares, to take over that portion of the business belonging to H. F. Howells and A. Douglas which relates to the repairing and overhauling of dynamos, motors and all kinds of electrical apparatus, &c., the sale of electric light accessories carried on at Hanley. First directors are: H. F. Howells and A. Douglas. Reg. office: 21a, Lichfield-street, Hanley.

STEEL WIRE COMPANY, LTD (162,320)—Private company. Reg. Jan. 1, capital £700,000 in £1 shares, to carry on the business of wire drawers and bar drawers of steel, iron, copper and other metals, manufacturers and owners of aerial and other ropeways, &c. First directors are E. Smith, A. Smith, Harry Smith, Herbert Smith, F. Smith and E. Smith (all directors of Doncaster Wire Company, Ordsal Wire Company, and E. and A. Smith Company).

TUAM ELECTRICITY COMPANY, LTD. (4,868)—Reg. in Dublin on Sept. 14, capital £8,000 in £1 shares, to carry on in Tuam and elsewhere the business of an electric light company. First directors are A. Eaton, O. Harman, G. Murray, A. O'Malley, T. J. Mellin and P. McTighe. Secretary: J. Daly. Reg. office: Dutlin-road, Tuam.

Prices of Metals, Chemicals, &c.

Tuesday, Feb. 3.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£125 0 0	£2 0 0	—
Electro Wirebars...	,,	£125 0 0	£1 10 0	—
H.C. wire basis......	per lb.	1s. 4¾d.	3/16d.	—
Sheet	,,	1s. 5⅝d.	—	⅛d.
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8¾d.	3/16d.	—
Brass 60/40—				
Rod, basis	,,	1s. 0¾d.	¼d.	—
Sheet, basis	,,	1s. 4⅝d.	—	—
Wire, basis	,,	1s. 3⅞d.	—	—
Iron—				
Cleveland Warrants	per ton	£9 2 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£39 0 0	—	—
Lead Pig—				
English	,,	48 10 0	£1 0 0	—
Foreign or colonial	,,	47 10 0	£1 5 0	—
Tin—Ingot	,,	384 0 0	—	£5 10 0
Wire, basis	per lb.	0 4 9	—	1d.

Salammoniac.—Per cwt. 95s. and 90s.
Sulphur (Flowers).—Per ton £23.
,, (Roll Brimstone).—Per ton £22 10s.
Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.
Copper Sulphate.—Per ton £50.
Boric Acid (Crystals).—Per ton £74.
Carbon Bisulphide.—Per ton £56.
Sodium Bichromate.—Per lb. 9d.
Sodium Chlorate.—Per lb. 6d.
Rubber.—Para fine, 2s. 7d.; plantation 1st. latex 2s. 9¼d. lb.
Shellac.—T.N. Orange, 850s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd, and the rubber figures by W. T. Henley's Telegraph Works, Company.

Thirty-Seven Years Ago.

[From The Electrician, Feb. 3, 1883.]

Novel Uses for Electricity (Leader).—We do not want to see the electric current diverted to the use of private assassination; and, whatever the assassin himself may say about it, we do not want to annihilate him by the same agency. But, unwelcome as may be the fact, we must put up with it, as we put up with dynamite and the other deadly sins. They have all been turned to harmless account, and we expect the same of the killing capabilities of electricity. . . . The proposal to slaughter animals by electricity is not original. Dr. Richardson, whose name is associated with many curious suggestions, tried this one some years ago. We do not exactly know why. Nominally, the idea was to cause a painless death. Human experience in these matters is very limited, and, as we cannot consult the animals, it is impossible to affirm what sort of death they like best, and which one is the least painful. As a fact, however, it was found, firstly, that the meat so slaughtered was injured, some of it being rendered unfit for food; and, secondly, that the animals sometimes came to life again, much to the satisfaction, no doubt, of the professional wielder of the pole-axe, though probably not to that of the poor beasts. . . . Some creatures are very stupid, and others very unreasonable. A hen, for example, will run away minus her head, and we all know what eels are capable of in the way of obstinately presuming to live; but nobody supposes that feeling survives the first slash of the knife, or, if it does survive, all we san say is that the amount of prolonged cruelty inflicted on fish and poultry calls for the interposition of the humane far more than does the case of the higher creation, who, if they feel more acutely, die much more quickly. But there was one other objection to Dr. Richardson's proposal, and it applies equally to Mr. Lane-Fox's for the slaughtering of used-up horses—namely, the danger to the slaughterers. We understand that the animal is to stand on a metallic floor, which is connected to an electrical appliance of great power, and this in turn to a wire and a knob. If the horse's forehead comes in contact with the knob the horse will be stricken dead. Given an intelligent horse, duly trained to touch the knob, and the business is done. To train and persuade an average slaughterer to bring the knob to the horse's head would be not more easy, and far less safe. This, and the combined protest of every old maid against the injury done to the food of their favourite pets, may be trusted to keep Mr. Lane-Fox's device out of the knackers' yard for a long while yet to come.

Royal Institution.—Yesterday (Friday) evening Sir Wm. Thomson, F.R.S., was to lecture on "The Size of Atoms."

Prof. Helmholtz.—A telegram from Berlin, dated January 30th, says that the Emperor has ennobled the celebrated scientist Prof. Helmholtz.

Transmission of Power by Electricity.—The first of a series of articles on this subject by Prof. O. J. Lodge appeared in last week's "Engineer."

Proposed Telephonic Exchange for Aberdeen.—A scheme is on foot in Aberdeen to start a telephone exchange which shall work on a cheaper basis than that of the National Telephone Company.

Resignations.—Sir Charles Bright and Mr. Edward Bright have resigned the position they have held with the British Electric Light Company, the former as consulting engineer, the latter as a member of the board of directors.

The Telephone in India.—At the request of H.E. the Commander-in-Chief, instructions have been issued for putting up, before the next season, telephonic communication between Sir Frederick Roberts' usual residence, "Snowdon," at Ootacamund, and the office of the headquarters, and any other Government departments he may consider necessary, the necessary "exchange" station being the Government Post Office. So says a contemporary.

Standard Wire Gauge.—At a recent meeting of the Wolverhampton Chamber of Commerce it was reported that the council had written to the Board of Trade saying that, though the standard wire gauge proposed by that Department was not in every respect such as they would have liked, yet they felt it would fulfil the purposes of a national standard wire gauge. They were so anxious to see a workable gauge introduced that they preferred not to make any suggestions lest they should hinder, or possibly frustrate, its adoption.

Electric Communication in Trains.—Sir Edward Watkin's somewhat loose and illogical statement at a recent meeting of the South-Eastern Railway Company that, though the company had its trains fitted with electric communication between passengers and guard, these had not been used once in six months, and therefore they were useless and needless, has been severely and rightly criticised by correspondents of the "Daily News." Their argument is "prevention is better than cure," and that the fact that the communications had not been used showed how effectual they were.

Electric Lighting in St. Martin's-in-the-Fields.—The vestry of St. Martin's-in-the-Fields will oppose all the provisional orders referring to their district on the following grounds: "That they seek to set aside the provisions of the Electric Lighting Act of 1882, and the rules of the Board of Trade in relation thereto, and to extinguish the right to control the public streets now vested in the local authority; that there is no provision for a regular and efficient supply of electricity, nor for the security of the public against personal injury, inspection by the local authority, or for a reduction in price after the payment of a dividend of, say, 10 per cent.; that the companies seek, without obtaining consent of the vestry, power to break up the public streets, to place wires above ground, and to acquire sites for lighting stations." The vestry also consider that no concession to a company should be for more than 14 years, that the vestry should have power to inspect the company's accounts, and that penalties should be exacted for failure to execute the proposed works within a reasonable time.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF
ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE
ESTABLISHED 1861.

No. 2,178. [Vol. LXXXIV. No. 7.] FRIDAY, FEBRUARY 13, 1920. PRICE SIXPENCE.
By Post, 7d. Abroad, 9d.

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Notes.

The King's Speech and Electricity Supply.

IN his speech made at the opening of Parliament on Tuesday last HIS MAJESTY foreshadowed the introduction of a Bill during the coming session "for the creation of an adequate supply of cheap electrical and water power." This, of course, is the new Bill promised at the end of last session, when the Electricity (Supply) Act was shorn of a number of its more contentious and coercive clauses. It would, therefore, seem that we are to have another fight on this question, and that attempts will again be made to improve the conditions of electricity supply in this country by Act of Parliament. As however, the PRIME MINISTER pointed out in reply to a criticism that the legislative programme was overloaded, the fact that the King's speech foreshadows a certain Bill does not necessarily mean that that Bill will be introduced. But, in our view, now that the Government has started to deal with the law of electricity supply, it should continue its task to its conclusion. Last year's Act gives a great deal, but it gives no power to deal with the reactionary element, which though small we are sorry to say is still existent, except by a policy of blockade. Something more positive is required, and the re-introduction and enactment of certain clauses, especially those of a financial nature, which were omitted in the scurry at the end of last session, should provide it.

The Problems of the "Third Party" in Industry.

THE Whitley report which proposed setting up joint councils of employers and employed for the solution of industrial disputes neglected to recognise the existence of any third party. The result is that a number of employees, of the kind conveniently known as salaried official, have taken upon themselves the organisation of a "third party" to represent their interests. This work of organisation has been going on quietly for some months, but has been forced into the glare of publicity by the Labour Party, or that part of it which is known as the Labour Research Department, taking an interest in the proceedings. A conference to inaugurate a National Federation of Professional, Technical and Supervisory Workers was held on Saturday last under the chairmanship of Mr. G. D. H. COLE, of the Labour Research Department, and at this conference it was agreed to form a federation with the above title for the promotion of common action and for the advancement by united action of the economic and social interests of its members. It is stated that the impression that the Labour Party organised the conference with a view to including middle-class interests within its own ranks is erroneous. But nevertheless the present situation rather reminds us of one in the fable of the wolf and the lamb: and we all remember what happened on that occasion. Let the National Federation of Professional, Technical and Supervisory Workers take the hint before it is too late and act accordingly. We are glad to learn that the Society of Technical Engineers realise this danger. For at the meeting they moved an amendment expressing the view that professional associations should be independent of employers' unions on the one hand and of manual workers' unions on the other, and free to negotiate with both in the best interests of the professional worker. The rejection of this amendment, as Mr. NORMAN WYLD, general secretary of the Society of Technical Engineers, points out, shows a desire on a part of the Federation for association with one or other of these classes.

Two Sides of the Question.

AN interesting light on this side of the question is thrown by our contemporary "The Chemical Age," which publishes the opinions of six well-known Labour Members—Mr. J. R. CLYNES, Mr. ARTHUR HENDERSON, Mr. W. BRACE, Mr. W. THORNE and Mr. J. WIGNALL—and of Mr. SEARLE, of the National Association of Industrial Chemists, and Dr. RODD, of the British Association of Chemists, on the advantages or otherwise of organisation among the middle classes. The Labour Leaders appeal to the professional classes to join hands with the manual workers "not merely for personal improvement, but for a higher level of national prosperity." But Mr. SEARLE and Dr. RODD are not quite so sure about the benefits of amalgamation, and neither are we. Indeed, we think that any federation of professional men would do very much better to stand on its own bottom than to ally itself with any organisation of either capitalists and shareholders on the one hand or of manual workers on the other. This is said in no spirit of antagonism, but simply because we feel that this new "third party" has got to fight its own battles because it has its own problems. Moreover, both the employers and the Labour interests would be the stronger for this abstention, for there is nothing like a united front and an unanimity of interests.

Scientific Attachés to British Embassies.

Even before the war the question of the reform of the Consular service was exciting much attention, one point, often emphasised, being the desirability of including technical and commercial attachés in the most important Embassies and Legations. We notice that the British Science Guild has conveyed a request to the Foreign Office suggesting that our Government should follow the principle, recently adopted by the United States, of appointing scientific attaché and assistant scientific attachés. At present such attachés have only been appointed to the American Embassies in London, Paris and Rome, but this appears to be a temporary measure. At the present time, when every effort should be made to encourage foreign trade (especially trade involving the application of science to industry and therefore of educational and scientific value), such a step has much to recommend it. The Foreign Office, however, rejects the suggestion, proposing instead that the work of disseminating foreign intelligence should be privately undertaken by research and technical associations. This proposal overlooks the advantages of official connection with such scientific enquiries, which might often greatly enhance the facilities for obtaining information. It also appears in contrast with the aim of establishing relations between the Foreign Office and the Board of Trade, which was understood to be a feature in the work of the Department of Overseas Trade, connected with both these Government Departments. The Department of Overseas Trade has admittedly had to contend with great difficulties and has shown energy. Its most recent action in inviting British firms to notify the Department of prospective visits to foreign countries, so that intimations may be sent to Consular officers, shows an enterprising spirit. We fear that in other quarters the question of encouraging foreign trade is viewed much less enthusiastically.

Ideal Home Exhibition.

After an interval of five years the Ideal Home Exhibition, organised by the "Daily Mail," was opened at Olympia on Wednesday in last week and will continue open until February 25. From its inauguration some years ago this Exhibition has always been a popular one, not only because it is well advertised, but also because the exhibits are of real interest. On this occasion there is no doubt that large crowds will visit Olympia to see the latest suggestions for carrying out housing schemes beyond their present unsatisfactory paper stage. The almost entire disappearance of the domestic servant has also made necessary the adoption of labour preventing and labour saving methods. And this is essentially where electricity can play a great part both in driving labour saving appliances and less in making their use necessary by the added cleanliness and convenience which it brings into the home. We are glad, therefore, to see that electrical devices are much to the fore on the stands, and to note moreover that the "Daily Mail" proposes to send the whole of its staff throughout the country to visit the Exhibition in order presumably that they may be brought up to date in regard to their knowledge of housing and the way in which houses should be equipped. This idea is an excellent one, which we hope will give the sub-editorial and reporting staffs at any rate a better conception of the way in which electrical apparatus really does work. It is also an idea we feel very strongly which should be extended, and electricity supply undertakings and manufacturers might well follow the example of our contemporary and send as many of their staff as possible to this Exhibition free of cost. The chief engineers should not be omitted from the party. In many ways it is a pity that it is not possible at the present time to organise an electrical exhibition, but as far as the staffs of supply undertakings or manufacturing enterprises are concerned the Ideal Home Exhibition has even a higher educational value, as there is to be found not only electrical but other apparatus, so that competing ideas and methods can be placed in contrast and useful deductions drawn.

Organisation and Production.

An interesting report on the present position of the German chemical industry has recently been published. It comes from a body of twenty members of the Association of British Chemical Manufacturers with the addition of four delegates representing various Government interests, and gives an account of a visit paid to various chemical works in Western Germany last year, with deductions drawn from what was seen. This body comes to the conclusion that there is no witchcraft about the matter, but that German success in the chemical industry was obtained by honest labour. The outstanding fact is, however, that the German industry has been one stupendous organisation for promoting and effecting the application of science to industry. Indeed, expert knowledge has been used and generously paid for, while every effort has been made to cut down the cost and increase the efficiency of every process. Naturally this state of things does not altogether exist at present, the all-pervading labour trouble is effecting the output, and wages have, of course, risen enormously. There is, however, one useful lesson which can be drawn from a perusal of this report. That is, that it is no good expecting the worker to increase his production, unless the managerial staff is also carrying out its functions in the best possible way. The skilled worker has at least good powers of criticism and is quite intelligent enough to know when the efficiency of the management is not all that it should be. There has been an instance of this in the Brinsmead case, which has been dealt with fully in the daily papers during the last fortnight. We need not go into details; but the charge is that the men were not working their hardest and the reply is that it was impossible to do so owing to shortcomings in the organisation of the factory. This latter view incidently seems to be receiving the support of other piano manufacturers. We do not pretend to know anything about piano making, but of this we are certain that adequate production of commodities, whether it be musical instruments, chemical re-agents or electric light fittings, cannot be obtained unless everyone, from the managing director to the labourer's mate, is working not only as hard, but as efficiently as possible. We may add that the appointment of a similar committee to report on the German electrical industry would produce an interesting and instructive document.

The Minimum Charge—An Undesirable Policy.

When electricity supply undertakings were cribbed and confined by the provisions of the old Electric Lighting Acts they were given some slight alleviation of their lot by being allowed to impose a minimum charge. If the revenue from a consumer in any one quarter did not reach a certain minimum amount, the undertaking was allowed to charge this latter amount in order to recuperate itself for the outlay involved in providing the connection and supplying the current. In the early days this minimum charge may have been insisted on, though with the relatively low efficiency carbon lamp and the high rates charged it was probably even then but infrequently required. During recent years it has been little employed, even when legally permissible, and it is therefore with regret that we notice an increasing tendency among electricity supply authorities to reimpose it. To do so is an unwise policy. It is also unfair, as the charge must fall principally on the small consumer. The householder gains little enough relief from the present high prices of all sorts of commodities; but he should be able in the summer quarter to economise to a certain extent upon his electric light, thanks to that curious piece of legislation the Daylight Saving Act. But as matters stand he is not allowed even that relief, for in that quarter he must consume or waste sufficient units to bring his electric lighting bill up to the minimum amount or pay for what he has not had. This in spite of the fact that in the other three quarters his bill may be largely above the minimum. Such a state of affairs is irritating to say the least of it, and would be much better replaced by a campaign to persuade the consumer to use electricity on an increasing scale for domestic purposes of all kinds and thus do away with the minimum once and for all. Or if there must be a minimum, it should be reckoned on an annual and not on a quarterly basis.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

Prof. W. H. Eccles contributes an article on "The Algebra of Ionic Valves" on page 162. This article forms an addendum to a Paper recently read before the Physical Society upon the measurement of the parameters of triodes and forms a useful introduction to the theory of the tubes.

Mr. R. O. Kapp contributes an article (page 164) on "Losses in Transformers" in which he differentiates between the iron and the copper losses and discusses what proportion each should bear to the whole from the points of view of both economy and efficiency.

On page 165 we publish an abstract of an article by Mr. Frank Hershey on "The Voltage Regulation of Distributing Feeders," in which he points out that there are certain disadvantages in regulating the voltage of a system from the generating station. There are two alternative methods of voltage regulation by compensating the voltage drop in some way or by the installation of conductors in such sizes as to provide a negligible drop. Of these the former will generally be the more economical. Various types of regulators and systems of using them are described

On page 168 we describe various electrical installations in small dwellings which have been recently carried out on Henley's well-known wiring system.

On page 169 we give an account of the discussion which took place at a recent meeting of the Illuminating Engineering Society on "Colour Matching."

On page 170 we begin our account of the exhibits of electrical interest which are to be found at the Ideal Home Exhibition which is being held at Olympia, London, until February 25.

On page 172 we give a short account of an address delivered by Sir Robert Hadfield to a recent meeting of the Faraday Society on the "Work of Faraday."

It is now just 50 years ago since the telegraph system of this country was handed over to State ownership. In our Leading Article on page 175 we give some account of the technical development that has taken place since that time.

An abstract of the annual report and accounts of the Pacific Cable Board appears on page 176.

On page 169 we publish an extract from the considered reply to the discussion on their Paper on "Carbon Arcs for Searchlights," recently read before the Institution of Electrical Engineers, by Messrs. C. C. Paterson, J. W. T. Walsh, A. K. Taylor and W. Barnett. This part of the reply refers to a point raised in our Editorial Note commenting on the Paper which appeared in our issue of December 5, 1919.

In our correspondence columns (p. 173), Mr. W. F. Dunton calls attention to two methods of calculating the best series-parallel arrangement of cells given in Fowler's Electrical Engineers' Year Book, and comments on the inaccuracy of these methods under certain conditions. He proposes a third method which overcomes the difficulties mentioned. Mr. F. Bourne comments on some obscure points in an article by Mr. D. C. Gall on "The Alternating-current Track Circuit," which was published on page 244 of The Electrician for September 5, 1919. Mr. Gall replies.

On page 178 we describe a metal with a negligible resistance coefficient which has been put on the market by the British Thomson-Houston Company, for use in thermostatic apparatus, and curves showing the performance of this metal are given.

Arrangements for the Week.

FRIDAY, Feb. 13th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Annual General Meeting. Presidential Address by Prof. C. H. Lees, D.Sc., F.R.S. Paper on "Atmospheric Refraction during Total Solar Eclipses," by Sir Arthur Schuster, F.R.S.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Gas Manufacture," by Mr. F. E. Heenan.

SATURDAY, Feb. 14th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, London, W. Lecture on "The Astronomical Evidence bearing on Einstein's Theory of Gravitation: Deflection of Light in the Sun's Gravitational Field," by Sir Frank W. Dyson, F.R.S. (Lecture III.)

MONDAY, Feb. 16th.

Batti-Wallahs' Society.

1 p.m. At the Holborn Restaurant, London, W.C. Subject: "Electricity in Warfare," by Major T. Rich, O.B.E.

Institution of Electrical Engineers.—Informal Meeting.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn Buildings, High Holborn, London, W.C. Paper on "Automatic Telephony for Private Branch Exchanges," by Mr. A. B. Eason.

Institution of Electrical Engineers.—Liverpool Sub-Centre.

7 p.m. At the University, Liverpool. Paper on "A Critical Survey of Power Supply in the Rhine Valley," by Lieut.-Col. F. C. Aldous, D.S.O., and Mr. A. E. L. Scanes, M.A.

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Recent Researches in the Cellulose Industry," by Mr. C. F. Cross, F.R.S. (Lecture I.)

TUESDAY, Feb. 17th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "Magnetic Susceptibility," by Prof. E. Wilson, M.Inst.C.E. (Lecture I.)

Institute of Metals.—Birmingham Local Section.

7.30 p.m. At Chamber of Commerce Buildings, New-street, Birmingham. Paper on "Radiography of Metals," by Major Hall-Edwards.

Institution of Electrical Engineers.—North Western Students' Centre.

7.30 p.m. At Houldsworth Hall, Deansgate, Manchester. Paper on "Central Station Boiler Practice," by Mr. K Habershon.

WEDNESDAY, Feb. 18th.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "English Canals and Inland Waterways," by Mr. S. Preston.

Institution of Electrical Engineers.—Wireless Sectional Meeting.

6 p.m. At the Institution of Civil Engineers, Gt. George-street, London, S.W. Paper on "Wireless Telephony on Aeroplanes," by Major C. E. Prince, O.B.E.

Industrial League and Council.

7.30 p.m. At Central Hall, Westminster, London, S.W. Subject: Evolution of Modern Methods in Industry," by Mr. W. J. Grosart.

Liverpool Engineering Society.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "Steel Wire and Its Manufacture," by Mr. E. A. Atkins.

THURSDAY, Feb. 19th.

Electrical Power Engineers' Association.—
Manchester District Section.

7 p.m. At the Milton Hall, Deansgate, Manchester. General Meeting. Address by Ex-President.

FRIDAY, Feb. 20th.

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Resumed discussion on "Recent Advances in Utilization of Water-Power," by Mr. E. M. Bergstrom.

Institution of Electrical Engineers.—
Liverpool Students' Sub-Centre.

7.30 p.m. At The University, Liverpool. Paper on "Central Station Boiler Practice," by Mr. K. Habershon.

Junior Institution of Engineers.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper on "Obscure Points in the Theory of the Internal Combustion Engine," by Prof. F. W. Burstall, M.Sc.

The Algebra of Ionic Valves.

By W. H. ECCLES, D.Sc.

At a recent meeting of the Physical Society, before entering upon the reading of a Paper on the measurement of the parameters of triodes, I sketched briefly the outline theory of these tubes. This foreword does not appear in the Paper, and it has been suggested to me that it would, if written, constitute a useful introduction to the theory of the tubes. I therefore offer it separately as follows, dividing the treatment into the theory of two-electrode tubes and that of three-electrode tubes.

DIODES.

In tubes possessing two electrodes—an anode and a hot cathode—the physical conditions may be summarised in a simple mathematical form when the current is a practically pure electronic discharge. The electrons moving from the filament to the anode across the vacuum and constituting the current give rise to an electric field tending to cause the electrons near the filament to return to it. The effect of this restraining field may be represented as a back E.M.F. opposing the main battery in the anode circuit, and somewhat analogous to the back E.M.F. of polarisation occurring in a liquid electrolyte. It can be shown that the density of the space charge is greatest near the cathode and that, therefore, the back E.M.F. may be conceived to be localised near the filament. We may picture it in a sketch by drawing the conventional symbol for a voltaic cell at such a position as S in Fig. 1. The magnitude of this back E.M.F. will be represented by e_s. The voltage between anode and cathode will be represented by e_a, the current through the diode by i_a.

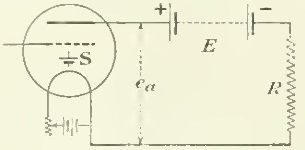

FIG. 1.

As the voltage is varied the current changes in the manner indicated by the characteristic curve of Fig. 2. From the origin O to some point K_1 the current increases relatively faster than the applied voltage, from K_1 to some point K_2 the curve is nearly straight, and at K_2 the current ceases to increase with increase of voltage—that is to say, saturation is attained. The portion OK_1 obeys the theoretical space charge equation

$$i_a = A'e_a^{\frac{3}{2}}.$$

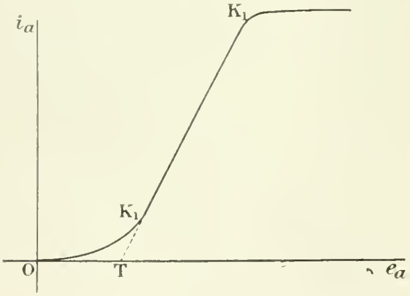

FIG. 2

The portion K_1K_2 departs from this equation because there are inequalities of temperature existing between the ends and the central portions of the filament, which lead to the various parts of the filament reaching the saturation condition in turn; the portion beyond K_2 and parallel to the voltage axis is unvarying because all the electrons emitted from every part of the filament are being carried to the anode and no more are available at the values of voltage appearing in the diagram. The points K_1 and K_2 are called the lower and upper knees of the characteristic curve.

If the nearly straight part be replaced by a straight line, and this equivalent line produced backwards to cut the voltage axis at T, its equation may be written

$$i_a = h_a(e_a - e_s),$$

where e_s is the value of OT and h_a is the gradient of the line—that is, the tangent of the angle of slope. The quantity h_a has the dimensions of a conductance and is constant: the quantity e_s is also a constant and may be interpreted as a back E.M.F. The tube may, therefore, be said to obey Ohm's law: but this obedience and the constancy of h_a and e_s come about, it should be remarked, because of the tapering of the temperature of the filament from its centre to its ends, which is a rather artificial mode of producing conformity with Ohm's law. Nevertheless, it proves very convenient in the derivation of the equations of circuits including diodes to treat the tube as obeying Ohm's equation as written above.

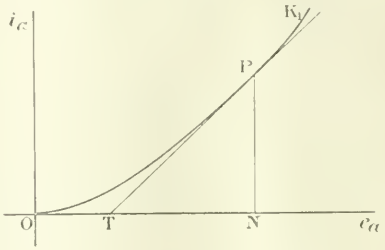

FIG. 3.

Turning now to the portion of the curve corresponding to voltages too low to draw the saturation current from even the coldest part of the filament, taking any point P, and drawing the tangent line as shown in Fig. 3, we find from the space charge equation that the gradient of the tangent line is

$$\frac{di_a}{de_a} = \tfrac{3}{2}A'e_a^{\frac{1}{2}}.$$

We shall, for short, call this h_a. Moreover, we have

$$OT = ON - TN$$

if PN be the ordinate of the point P. Call the intercept e_s; then

$$e_s = e_a - i_a/h_a$$
$$i_a = h_a(e_a - e_s).$$

We also have

$$e_s = e_a - A'e_a^{\frac{3}{2}}/\tfrac{3}{2}A'e_a^{\frac{1}{2}}$$
$$= \tfrac{1}{3}e_a.$$

The equation for i_a becomes the equation of the curve when h_a and e_s are given their values in terms of the co-ordinates of the point P, but it becomes the equation of the tangent line if h_a and e_s be held constant. In many physical problems we may identify a very small length of the curve with an element of the tangent at a point within that length, and may therefore regard h_a as instantaneously the conductance at the point P and e_s as the back E.M.F.; in such cases h_a may be called the differential conductance of the tube at the adjustment in question, and the diode may be treated in calculations just as if it contained a constant back E.M.F. e_s and obeyed Ohm's law. The cases in which this simplification cannot be allowed are those in which the curvature of the characteristic is the property, or one of the properties, being utilised in the experiment under investigation.

TRIODES.

Similar considerations can be applied to the valve with three electrodes when, as is common, the current flowing from the grid to the filament inside the tube is negligible. The electrostatic theory of the grid or other control electrode shows that when it is at a different potential from the filament it superposes an electric field upon that existing in the space charge and therefore modifies the back E.M.F. due to this charge. When the control electrode is made positive relative to the filament the back E.M.F. is reduced by an amount proportional to the voltage of the electrode, which is equivalent to the introduction of a voltage of equal value into the anode circuit and assisting the anode battery. The proportional constant is usually greater than unity and may be called the voltage factor of the tube; its symbol is g. If the P.D. between the control electrode and the filament is e_g, the E.M.F. effective in the anode circuit for driving the electron current is now

$$e_a+ge_g-e_s,$$

instead of the voltage

$$e_l-e_s$$

occurring in the diode. The quantity e_a+ge_g appears so frequently that it is convenient to name it, say, the "lumped" voltage, and to give it the symbol e_l. The theory of the triode is thus reduced to that of the diode. We have, in fact, along the nearly straight part of the characteristic curve

$$i_a=h_a(e_l-e_s).$$

When it is necessary to express the control voltage explicitly this may be written

$$\begin{aligned} i_a &= h_a(e_a+ge_g-e_s) \\ &= h_a e_a+h_g e_g+h_0, \end{aligned}$$

which is the equation first suggested by M. Latour.*
In this equation

$$h_g=gh_a \quad \text{and} \quad h_0=-h_a e_s,$$

and all are constants along the straight part of the characteristic.

From what has been said regarding the portion of the diode characteristic that satisfies the three-halves power law it is obvious that the equation connecting the anode current and the lumped voltage below the lower knee of the triode characteristic may also be written

$$\begin{aligned} i_a &= h_a(e_l-e_s) \\ &= h_a e_a+h_g e_g+h_0. \end{aligned}$$

In problems where the second differential coefficient of i_a with respect to e_a or e_g is unimportant the parameters h_a, h_g and h_0 may be treated as constants. In this case

$$\frac{\partial i_a}{\partial e_a}=h_a \quad \text{and} \quad \frac{\partial i_a}{\partial e_g}=h_g.$$

In other cases the equation for the curved portion below the lower knee must be written

$$\begin{aligned} i_a &= A'e_l^{\frac{3}{2}} \\ &= A'(e_a+ge)^{\frac{3}{2}}, \end{aligned}$$

which is Langmuir's equation for this section of the triode characteristic. For example, if a triode is being used on this lower portion as an amplifier, and not as a detector, we may use the linear equation and regard the parameters as constants; but if the rectifying properties of the valve are under consideration the Langmuir equation must be used. In this latter case h_a and h_g are still defined by the differential coefficients above but they are now functions of both e_a and e_g.

This matter has been fully dealt with from quite another view point and in a general manner by Prof. A. Press in a recent issue of THE ELECTRICIAN. H. J. Van de Bijl, R. Carson and H. W. Nichols have also made noteworthy contributions to the discussion of the theory.†

Consider the lumped characteristic in Fig. 4, and especially the straight part, of which the equation is

$$i_a=h_a(e_l-e_s).$$

This line is plotted in Fig. 1. The slope of the line is the angle marked in the figure and the tangent of the angle of slope—that is to say, the gradient of the line—is h_a. The back E.M.F. appearing in the tube is the intercept of the line on the lumped voltage axis of e_l. The constant h_0 is seen as the intercept of the line upon current axis. The differential resistance of the tube is the reciprocal of the differential conductance h_a—that is to say, is the co-tangent of the slope. This characteristic can be obtained in any actual case from either the family of e_g-i_a characteristics or from the family of e_a-i_a characteristics; and conversely, when the lumped characteristic is given the others can be derived. The results given by the lumped characteristics are valid over the greater part of the range of adjustments used in practice but are not valid in extreme adjustments. In other words, the voltage factor g is constant over nearly all the characteristics. It should be noticed that the lumped characteristic of a triode is identical with the e_a-i_a characteristic for $e_g=0$.

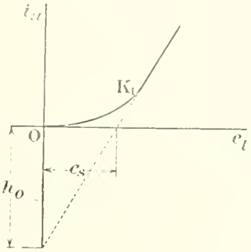

FIG. 4

An application of the above theory may be made to the problem given in Fig. 1. Here a resistance R is in series with the tube, of which the differential resistance is, say, r_a. The E.M.F. in the anode circuit is that of the battery E, the space charge back E.M.F. e_g, and the transferred grid voltage ge_g. The total resistance in circuit is $R+r_a$. Thus

$$i_a=\frac{E+ge_g-e_s}{R+r_a}.$$

Here e_s and r_a (or $1/h_a$) are constants of the tube, supposed known. The current is, therefore, now determined.

Suppose the P.D. at the terminals of R is to be utilised, as in an amplifier. Let v_g be the small change in e_g, so that the new e_g is the old e_g together with v_g. On writing down the new value of the current—say i_a+j_a—we have

$$i_a+j_a=\frac{E+g(e_g+v_g)-e_s}{R+r_a},$$

and subtraction gives

$$j_a=\frac{gv_g}{R+r_a},$$

which

$$=\frac{h_g v_g}{1+Rh_a}.$$

The output voltage of this one stage amplifier is therefore

$$Rj_a=\frac{Rh_g v_g}{1+Rh_a},$$

and the voltage amplification is the ratio of this to e_g, namely,

$$\frac{Rh_g}{1+Rh_a} \quad \text{or} \quad \frac{gR}{R+r_a}.$$

This result is correct on the curved part as well as the straight of the characteristic.

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* M. Latour, THE ELECTRICIAN, December 15, 1916.

† A. Press, THE ELECTRICIAN, January 9, 1920; H. J. Van de Bijl, p. 97, "Proc." Inst. Radio Engineers, April, 1919; J. R. Carson, p. 187, "Proc." Inst. Radio Engineers, April, 1919; H. W. Nichols, "Phys. Rev.," 13, pp. 404-414, June, 1919.

Losses in Transformers.

By REGINALD O. KAPP, B.Sc., A.M.I.E.E.

The losses in a transformer are made up of an iron and a copper loss. The former continues as long as the transformer is connected to the line, whether it is loaded or not. The latter only occurs when the transformer is working, and it is proportional to the square of the load. The annual iron loss in kilowatt hours per kilovolt ampere of transformer plant installed is obtained by multiplying the percentage iron loss by 8,760, which is the number of hours in a year. The annual copper loss depends on the way the transformer is worked. In a typical load curve before the writer, the average load is 39 per cent. of the transformer plant. In the case of this load curve the copper loss, which is proportional to the square of the load, is 27 per cent. of the copper loss which would occur if the transformers were working at full load all the year round.* The annual copper loss in kilowatt hours per kilovolt ampere of transformer plant installed is obtained by multiplying the percentage full load copper loss by 8,760, and multiplying the product by a factor which depends on the load curve. In the case we are considering this factor would be 0·27.

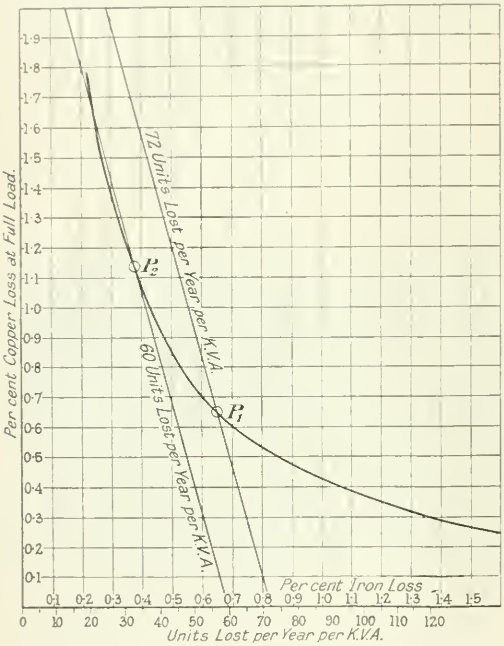

Fig. 1.—Energy Lost in a Transformer with Varying Ratio of Iron and Copper Losses.

Let us consider an example. Suppose a transformer is designed with equal iron and copper losses, both having the value of 0·65 per cent. This would correspond to point P_1 on the curve (Fig. 1). The total annual loss will be

$$8760 \times \left(\frac{0\cdot65}{100} + 0\cdot27 \times \frac{0\cdot65}{100}\right) = 72 \text{ kilowatt hours}$$

per kilovolt ampere of transformer plant installed. The slope of the straight line drawn through P_1 is such that

$$x = 0\cdot27y.$$

It will be seen in Fig. 2 where AB is drawn with the same slope that for any point P on this line

$$OB = Ox + xB = Ox + 0\cdot27Oy.$$

Hence any point on the straight line through P_1 corresponds to an annual loss of 72 units, and any point on another straight line drawn parallel to it would correspond to a different loss. The annual loss can be read off on a suitable scale where the straight lines cut the axis of X.

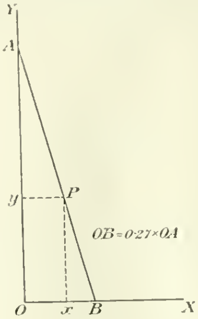

Fig. 2.

Let us now suppose that the designer can vary the dimensions of his transformer as to have an iron loss of only 0·38 per cent., and a copper loss of 1·14 per cent. These figures correspond to point P_2 on the drawing. The total annual loss will now be

$$8760 \times \left(\frac{0\cdot38}{100} + 0\cdot27 \times \frac{1\cdot14}{100}\right) = 60 \text{ kilowatt hours}$$

per kilovolt ampere of transformer plant installed.

If we assume that various dimensions of the transformer give losses corresponding to points on the curve shown in Fig. 1, it will be seen that to reduce the iron loss at the expense of the copper loss beyond P_2 would not result in any substantial gain.

Of the two alternative designs corresponding to points P_1 and P_2 the full load efficiency of the former is 98·7 per cent. and of the latter 98·48 per cent. It will be seen that for our example the more economical transformer has the lower full load efficiency.

How great is the gain in economy? It is represented by an annual saving of 12 units per kilovolt ampere. At a generating cost of ½d. per unit this represents a saving of 6d. a year for every kilovolt ampere installed. Capitalised at 12½ per cent., that is equivalent to a capital sum of 4s. So it would be worth while to add anything up to 4s. to the cost per kilovolt ampere of the transformer if by so doing one could get from point P_1 to P_2. In other words, a transformer costing 23s. 6d. per kilovolt ampere and having a full load efficiency of 98·5 per cent. might be a better investment than one costing 20s. per kilovolt ampere and having a full load efficiency of 98·7 per cent.

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* This figure is equal to

$$\frac{\Sigma\, \text{load}^2 \times \text{time}}{(\text{rated output of transformer})^2 \times \Sigma\, \text{time}};$$

for instance, if a 1,000 k.v.a. transformer is working 3 hours at 1,000 k.v.a. 3 hours at 750 k.v.a., 4 hours at 500 k.v.a., 8 hours at 250 k.v.a, and 6 hours at no load, the load factor would be

$$\frac{3 \times 1000 + 3 \times 750 + 4 \times 500 + 8 \times 250 + 6 \times 0}{24 \times 1000} = 40 \text{ per cent.},$$

the copper loss would be

$$\frac{3 \times 1000^2 + 3 \times 750^2 + 4 \times 500^2 + 8 \times 250^2 + 6 \times 0}{24 \times 1000^2} = 25 \text{ per cent.}$$

of the copper loss at a load factor of 100 per cent.

A manufacturer would not design a transformer to work at point P_1, that is with equal iron and copper losses, but, on the other hand, it is not usual to arrange for as high a ratio as $\frac{0{\cdot}38}{1{\cdot}11} =$ about $\frac{1}{3}$ which gave the greatest economy in our example. In the absence of figures specified by the customer, the manufacturer can hardly be expected to arrange for so high a ratio. If he has no reason to suppose that the customer will consider the question of losses on a more scientific basis than that of full load efficiency he will, at least in a competitive tender, be inclined to arrange for the best full-load efficiency, and this is obtained with a ratio of losses at or near unity. Hence the tendency has arisen to make transformers of which the full load efficiency is good, but the economy under working conditions not as good as it might be. Though this question of the most economical distribution of the losses is a refinement, our example shows that it is a refinement which may be expressed in terms of as much as 10 per cent. to 20 per cent. difference in the cost of the transformers. So it pays the purchaser to consider this question. What ratio of losses is best for a given case depends on the load curve at which the transformer will work, which is a matter that the purchaser must determine, and also on points connected with the design of the transformer which are known to the manufacturer. It is not possible to form a general rule from the purely imaginary example chosen for Fig. 1. The ratio given by point P_2 might lead to bad proportions of the transformer in other respects; it might involve departures from makers' standards which would unduly increase the cost or delivery of the plant, the points obtainable by the designer might be on a curve that differed from the one drawn through P_1 and P_2. Further, in the case of a small transformer having a lower general efficiency, the curve would be further from the origin, and the economical ratio of the losses would be nearer unity. In the case of a very large transformer with a greater general efficiency, this ratio might be a smaller fraction than $\frac{1}{3}$. Therefore, the general conclusion is that if the purchaser wants the most economical transformer the manufacturer can supply, he should state that the iron loss plus a specified fraction of the copper loss at full load, are to be as low as possible. This fraction depends on the load curve, and was for the typical case we have been considering equal to 27 per cent.

Voltage Regulation of Distributing Feeders.*

By FRANK HERSHEY.

In the design of new power plants, or the remodelling of existing plants, the aim of the engineer is to select such equipment as will result in the desired energy being delivered to the 'bus-bar at the minimum cost. Many devices are included to assist in obtaining a higher conversion of the energy in the coal or waterfall. To secure a small fraction of one per cent. increase in plant efficiency, the expenditure of additional capital is oftentimes justified. In laying out the distributing system, however, is the same effort made to carry efficiency through to the consumer—to maintain constant normal voltage at the recording meter—or are the power-plant economies being consumed by losses in the distributing feeders? Electrical appliances used in the household are designed for most efficient operation at a definite pre-determined voltage; and operation at a voltage other than normal impairs the service, results in increased cost to the consumer, as well as reduces the revenue to the central stations. The wattage and candle-power of lamps vary at the rate of slightly more than 1·5 and 3 per cent. respectively, for each per cent. change in voltage from normal. If the voltage applied to the terminals is 3 per cent. low, less current will be consumed, reducing the revenue to the central station by 4·5 per cent., and the illumination for the consumer by 9 per cent. The life of the lamp will be increased but the reduction in illumination is so great that the cost of light per candle-power-hour is increased. If the voltage is 3 per cent. high, the revenue will be increased 4·5 per cent., and the candle-power 9 per cent., but the life of the lamp will be reduced to such an extent that again the cost per candle-power-hour is increased.

Household appliances, such as irons, toasters, percolators, warming pads, broilers and curling irons require nearly as close regulation as the incandescent lamp, as the heating and also the power consumed varies as the square of the voltage applied. A 5 per cent. drop in voltage equals a loss of approximately 10 per cent. in revenue to the central station and 10 per cent. less energy is available for heating, so that unless the voltage is maintained at approximately the rated value, the appliances lose their value as conveniences and dissatisfaction results. The percentage of lighting load as compared to the total generating capacity of the plant may be small, but the incandescent lamp is used so extensively that its performance has been accepted by the public as a standard for judging the efficiency of the operating company. The goodwill of the public is of incalculable value to the central station. It is essential, therefore, that a uniform and proper voltage be maintained within reasonable limits on all lighting circuits.

Normal voltage may be maintained at the distributing centre, either by supplying a constant 'bus voltage and designing the distributing feeders for a negligible drop, or by varying the voltage supplied to the individual feeders by means of a regulator.

The voltage of a generator or a number of generators may be maintained automatically for all conditions of load at the station 'bus, or at any one centre of distribution on the system by means of a generator-voltage regulator. Where there are a number of feeders radiating from a station this method of regulation, however, will not be satisfactory (unless all of the feeders are laid out for negligible voltage drop which generally is uneconomical). Usually, the feeders are of different lengths, and the power demands occur at different intervals so that the voltage delivered at the centres of the several feeders will vary widely. It is impossible, therefore, to raise or lower the voltage of the station 'bus so that the voltage at each load centre is proportional to the demand at that centre. Each feeder should be considered as a unit. The system can be made simple and economical if care is exercised when the initial lay-out is made. Many existing plants could reduce the distributing costs and improve their service by investigating their feeding systems with the view to making them more symmetrical and of uniform regulation. Recording voltmeter charts taken at frequent intervals at various points on each feeder provide a means for detecting voltage irregularities. These, if uncorrected, may become magnified and not only impair the service, but appreciably effect the revenue.

In laying out a new system, or reconstructing an old one, the area to be lighted should be divided into districts and the maximum load to be handled in each district should be determined, bearing in mind the advantage of having feeders as nearly equal in capacity as practicable. This ensures symmetrical switchboards and feeder equipments and simplicity of maintenance. It is usual to consider the actual and anticipated loads in each sub-division, so as to take care of future as well as present requirements. Forethought in this respect often saves considerable expense in the future growth of the system. One district may be 90 per cent. loaded, while another only 25 per cent loaded. The latter, however, may be of such a character as to lead the lighting company to believe that there are prospects of a load equally as great as in the former. In laying out the feeder and the mains, the most economical cross-section of copper should be used, *i.e.*, the cost for the conductor, distributed over a period of time corresponding to the life of the feeder, should equal the cost for loss in energy due to the drop. The value of feeder regulation must be taken into consideration, however, as it would not be possible to use the most economical size of conductor without providing some form of regulation if the drop at maximum load is to be maintained within a reasonable percentage.

There are two alternatives—voltage regulators to compensate for the voltage drop in the feeder and the installation of conductors of such size as to provide negligible drop. The choice depends on the relation between the cost of the line and the regulator, plus the cost of losses in the line and regulator, and the cost of the feeder, using the larger conductors to reduce line drop plus the line losses. However, the regulator will compensate for variations in supply voltage, which cannot be accomplished by the use of larger conductors. The installation of a regulator will often be more economical even if the total cost somewhat exceeds the cost of the heavier conductors.

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* Abstract of article in the "General Electric Review" (U.S.A.).

To illustrate, assume that it is necessary to install a single phase, 2,300-volt lighting feeder of 75-ampere capacity, the load to be equivalent to full load four hours per day, 300 days per year. The most economical size of conductor would be No. 1 on the basis of a 15-year life for the feeder, copper at 20 cents. per pound, and allowing 2 per cent. for taxes, 5 per cent. for capital invested, 15 cents. per pound for scrap copper, and energy to supply losses at $0.0125 per kilowatt-hour, as well as proper charges for erection and removal. The cost per mile for the feeder would be approximately $184 and the drop would be 4 per cent. If not corrected, this drop (without considering the drop in the secondary distribution) would mean a reduction of over 12 per cent. in candle-power of the lamps and a loss of over 6 per cent. in revenue to the central station, or on the basis of 10 cents. per kilowatt-hour the annual anticipated revenue of $21,000 would be reduced $1,260. If larger size conductors were used to reduce the line drop it would necessitate the installation of 350,000 circular-mil cable to maintain regulation within 1 per cent. at the centre of distribution, such as can be accomplished by installing a regulator. This would cost approximately $248 per mile. On the other hand, if No. 1 conductors and a regulator to compensate for the drop to the load centre were used, the regulator, including the cost for losses and installation, would increase the cost of the feeder from $184 to $278. Unless the supply is subject to fluctuations, such as occur in feeders tapped from transmission lines where a regulator is necessary, the lower cost favours the installation of the 350,000-mil cable.

If, however, the feeder were 2 miles long, other factors remaining unchanged, the full-load drop would be 8 per cent. To maintain regulation within 1 per cent. at the load centre without a regulator would necessitate installing 1,500,000 circular-mil cable at a cost of $354 per mile; whereas the extension of the feeder would cut the charge for the regulator in half, making the cost to cover the installation of No. 1 conductors and regulator $231 per mile, or a difference of approximately 50 per cent. in favour of the latter installation. If the feeder were 3 three miles long, the saving effected by a regulator would be even more marked. In fact, the minimum cost is obtained when the entire range of the regulator is utilised in compensating for line drop. Inasmuch as the regulators selected would provide 10 per cent. boost and 10 per cent. lower, a total range of 20 per cent., the feeder could be extended for a distance of 5 miles. Normal voltage would be maintained at the centre provided the 'bus voltage was kept constant at a value such that the regulator stands in the neutral position when the load on the feeder is 50 per cent. of maximum. The regulator should lower the 'bus voltage 10 per cent. at no load, lower 5 per cent. at quarter load, be at neutral at half load, and should raise the 'bus voltage 5 per cent. at three-quarters load, and raise it 10 per cent. at full load. In this way the maximum benefit to be derived from the regulator will be obtained.

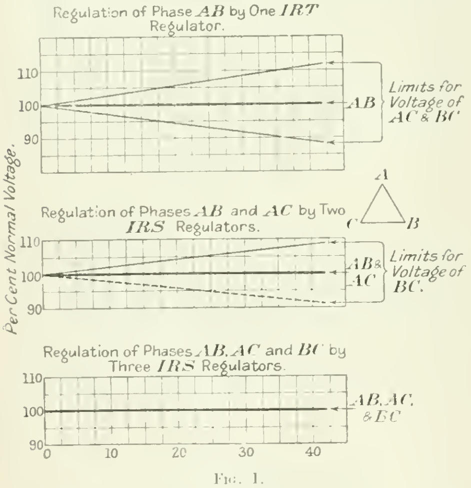

Fig. 1.

Voltage regulators are not necessary to maintain service. If they are considered merely as a means to improve the quality of service furnished the consumer, they may be justly referred to as a luxury. When their value to the central station is considered as a means for raising the efficiency of the system, for obtaining a greater return on invested capital, for effecting economies in feeder construction, as well as improving the service they cease to be a luxury and become a necessity. In laying out the feeding system, each feeder should be considered separately, its load analysed, present and prospective, with the same care as is given to the design of the station; by providing the proper form of voltage regulation, efficiency of operation will not stop at the 'bus but will be carried through to the consumer.

In the old direct-current system the various feeders differed greatly in length and were unequally loaded so that it became necessary to control each individual feeder. Several methods were employed:—

1. Connecting and disconnecting feeders at various points in the network.
2. Feeder regulating rheostats
3. Auxiliary 'buses.
4. Boosters.

For alternating current distribution, no method is as satisfactory as the booster or variable-ratio transformer method. Numerous designs of regulators have been developed, some cutting in or out of the circuit, sections of the secondary or series winding by means of a switch, others altering the position of the secondary winding with respect to the primary or changing the direction and amount of magnetic flux threading the series winding, thereby varying the induced voltage in this winding and providing a means for regulating the line voltage.

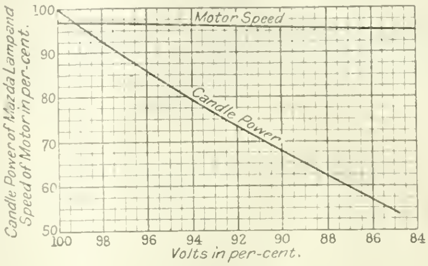

Fig. 2.

The modern design of regulator, designated as the induction regulator, has two separate and distinct windings, primary and secondary, connected respectively across and in series with the feeder to be regulated. The secondary or series winding is assembled on a circular stationary core, and the primary or exciting winding is also assembled on a circular core concentric with the stationary core, but arranged so that it can be partially rotated within the former. Voltage regulation is obtained by changing the position of the primary winding with respect to the secondary, so that the induced secondary voltage may be varied in value as in a single-phase regulator, or in phase relation to the line as in a polyphase regulator. The supply voltage is thus increased or diminished according to the change in load on the feeder. The induction type of regulator requires no more attention than other electrical apparatus and may be installed either at the generating station, substation, or with slight modifications, out of doors. The regulator can be designed for controlling either single or polyphase circuits, self or artificial cooling, and for any current or voltage for which it is practical to build generators or motors. Furthermore, it can be designed for either hand, remote-control, or automatic operation.

The automatically-operated regulator requires an auxiliary equipment consisting of potential transformer, contact-making voltmeter, relay switch, one or more current transformers and line-drop compensator. The potential transformer steps down the line potential for the contact-making voltmeter in the same manner as for the usual indicating voltmeter on the switchboard. The contact-making voltmeter responds to variations in the line voltage. When they exceed 1 per cent. either way from normal it completes either the raising or lowering circuit to the relay switch, which is introduced to provide a means of handling the heavier motor current. Thus the regulator raises or lowers the supply voltage in accordance with the demand. When normal voltage has again been established, the control circuit is automatically opened and the regulator comes to rest. The current transformers and line-drop compensator are used as a means of reproducing in miniature the resistance and reactance drops in the line, so that the regulator can be used for maintaining voltage at the desired value at a distance centre, irrespective of a change in load or power-factor.

Automatically operated regulators present so many advantages over the other methods of operation, and are used almost exclusively at the present time. Only this type of regulator will be considered in discussing the application of voltage regulators for the control of distributing feeders, for outdoor installations, and for sub-stations tapping high-tension transmission lines.

CONTROL OF DISTRIBUTING FEEDERS.

The feeding system may be single-phase, quarter-phase, three-wire or four-wire, or three-phase, three-wire or four-wire. The different types of systems will be considered separately.

Single-phase Feeders.—The automatic regulation of single-phase feeders presents no difficulties, as there is one definite point to be considered and the boost or lower of the regulator is directly added to or subtracted from the voltage of the feeder. If regulation to compensate for drop to some distant centre is desired, one current transformer and line-drop compensator must be included among the auxiliaries, but these would be omitted if the regulator is merely to maintain the voltage constant at the station.

Three-phase Feeders.—*Case* 1. It may be desirable to connect the lighting load on only one phase of a three-phase feeder. While one single-phase regulator in this case would regulate the voltage satisfactorily, variations in the power-factor of the load would affect the phase relations of the currents from the current and potential transformers causing unsatisfactory compensation, unless two inter-connected current transformers are used. In such an installation, the regulator has its secondary winding in series with the line and its primary connected across the phase, so that at unity power-factor the line current, and consequently the series transformer current, is displaced 30 deg. from the phase voltage or the corresponding secondary current of the potential transformer. If the load on the feeder is balanced, and the power-factor remains constant at approximately unity, satisfactory regulation can be obtained as the line-drop compensator can be set to counteract the error caused by the difference in phase relation of the currents from the current and potential transformers. Should the power-factor vary considerably, the phase displacement in the currents may become such that practically no compensation can be obtained. By using two current transformers inter-connected, one in series with each leg of the regulated phase, a resultant current is obtained which is proportional to the current causing the drop, and which bears the same relation to the potential transformer current as the line current bears to the phase voltage so that correct compensation can be obtained irrespective of unbalancing in load or change in power-factor.

Case 2.—Where lighting is connected on only two phases of a three-phase system and motors are connected to the same feeder, two single-phase regulators and three inter-connected current transformers should be used. If the third current transformer were omitted, proper compensation could not be secured on account of the phase displacements in the current and potential transformer circuits.

Case 3.—Where lighting and power are connected to all three phases of a three-phase feeder, either one three-phase regulator, two single-phase, or three single-phase regulators may be used, depending on the balancing of the circuit.

The operation of any automatic induction regulator, whether single-phase or three-phase, is directly dependent on the contact-making voltmeter which is a single-phase device. Consequently, when a three-phase regulator is used, the voltage on all three phases will be changed equally, the increase or decrease depending on the adjustment required by that phase across which the contact-making voltmeter is connected. When two single-phase regulators are used, two of the phases will be adjusted independently and held at the desired value. The regulation of these two phases will tend to improve the voltage across the third or non-regulated phase, but the latter will be subject to variations under unbalanced conditions of load, which cannot be entirely controlled. When three single-phase regulators are used the voltage on all of the phases will be maintained at the distributing centre at a constant value regardless of the unbalancing.

Under balance conditions of load the same regulation is obtained with a three-phase regulator as with either two or three single-phase regulators. With a balanced load the same adjustment of voltage with a change in load will be required on all three phases. With an unbalanced load the voltage adjustments necessary to maintain constant and eqaul voltage on all phases depend not only on the change in load, but also on the unbalancing in current. For instance, assume that the load on the feeder is made up of a three-phase balanced motor load of approximately 85 per cent. power-factor and an unbalanced lighting load. Under a condition of 15 per cent. unbalancing a variation of 4 per cent. above and 4 per cent. below normal might be obtained on the two non-regulated phases with the three-phase unit, 3 per cent. variation either above or below normal on the one non-regulated phase if two single-phase regulators were used; whereas normal voltage would be maintained on all three phases if three single-phase regulators were used.

In controlling a three-phase three-wire feeder there are no conditions of operation under which the use of two single-phase regulators will not result in as good or better regulation than can be obtained by the use of one three-phase unit. Furthermore, if only two single-phase regulators are installed and the unbalancing becomes excessive, it will only be necessary to install the third single-phase regulator in order to obtain satisfactory regulation; whereas it will be necessary to replace the three-phase unit with three single-phase units at a much greater increase in cost. The single-phase regulators are also more flexible. The same regulators can be used without change if the system is changed from three-wire to four-wire grounded neutral distribution. The only advantages for the three-phase regulator are less floor space required and less inspection, since only one set of auxiliaries have to be inspected. The cost and efficiency for two single-phase regulators are about the same as for the three-phase unit.

Case 4.—Three-phase four-wire feeders are common, the fourth wire being earthed. For such systems three single-phase regulators should be used, the secondaries being connected in series with a phase wire and the primaries excited from phase wire to neutral. Satisfactory regulation can be obtained by using this method, as it is practically equivalent to three independent single-phase feeders. If the load is unbalanced, current will flow in the ground wire and an additional line-drop compensator and current transformer will be required to provide compensation for drop in this wire.

Two-phase Feeders.—Two-phase systems may be three of four-wire. In the case of four-wire distribution, correct regulation can be obtained by using a two-phase regulator if the load is balanced. In the three-wire distribution, however, for either balanced or unbalanced conditions of load, or if the load is unbalanced in the four-wire distribution, two single-phase regulators should be used. Each phase will then be controlled independently and close regulation can be maintained. If a two-phase unit were installed, the non-regulated phase would be subject to variations since the line drop in the regulated phase affects the voltage of the other phase and no means can be provided for correcting this condition.

Regulators for Outdoor Installations.—In laying out the feeding system, a size of conductor to meet the probable future demand should be selected. Unfortunately, communities do not always expand as expected; some sections build up compactly and steadily, while others are irregular in their growth or spread over a greater area than originally contemplated when the feeders were installed. It would be uneconomical to replace or reinforce the present lines or to install additional feeders in such sections. The only solution of the problem is to establish two or more load centres, each supplied from the main feeder, but having the voltage maintained at normal regardless of variations on the main feeder. This can be done by the installation of induction regulators designed for outdoor installation. Usually these regulators are installed at the load centre, making it unnecessary to provide auxiliaries to compensate for additional line-drop, although the regulator may be installed at a point distant from the centre if this is desirable and arranged to compensate for the drop by employing the usual accessories similar to the station regulators.

This type of regulator is also well adapted for controlling the lighting circuit of an industrial plant supplied with energy from a feeder used primarily for the distribution of power and, therefore, probably non-regulated at the station. The advantages of improved illumination are appreciated by industrial plant managers; but no matter how carefully the lamps, reflectors and fixtures are selected to provide suitable illumination of the work and surroundings, the desired results will not be obtained unless the proper voltage is applied and maintained at the lamp terminals.

Voltage Regulation of Sub-stations Tapping Transmission Lines.—During the past decade great strides have been made in the distribution of energy at high voltages over great distances from points where power can be generated more economically and more efficiently. Numerous small generating stations, heretofore entirely isolated, have been tied together, the less efficient generating equipment in many cases being dismantled and the station converted into a sub-station, or being replaced by an outdoor sub-station for the transformation of energy from the transmission voltage to a voltage suitable for local distribution. In order to provide voltage regulation it is necessary to install induction regulators, either indoor or outdoor. In fact, the need for regulation has been accentuated as the line-drop on the local system is unchanged and the transmission line is subject to variations which will be impressed on the feeding system. In an installation of this kind, a regulator will perform the double function of correcting variations in the supply voltage and also compensating for drop in the distributing feeder.

Electricity Supply in Small Dwellings.

Perhaps the most urgent of reconstruction problems is that of housing. In this development the electrical engineer ought to play a great part, and it behoves us all to be wide awake, and thus to ensure the installation of electricity for all domestic purposes in the new houses which are now being put up. In many cases we are glad to say this is being done, but there are as many and more where it should be done.

Fig. 1.—Modern Cottages Equipped on Henley's System.

In considering this question from the ways and means point of view the electrical engineer must first decide what system can most efficiently be used. In this connection he cannot do better than look into some details and figures which have lately been put forward by Messrs. W. T. Henley's Telegraph Works Company in an artistic booklet entitled "Small Dwellings." This booklet gives an interesting survey of what has been done by the firm in installing electric light in what, for want of a better term, may be called "workmen's dwellings."

Now one of the great arguments against electric light in this class of dwelling has been the cost of installation, and unfortunately the conditions under which the country is now living have increased that cost. Messrs. Henleys, however, are able to show that by using their system great economies can be effected, and that taking into account all the known advantages of electric light it is economically sound to use electric light in these small dwellings. For our part we consider that it is a'so absolutely necessary for hygienic reasons that electric lighting should be used wherever possible.

The general details of Messrs. Henleys' wiring system are, of course, well known to our readers, but as showing what can be done, it will be interesting to give some examples of installations that they have recently carried out in small dwellings. Fig. 1 shows three of about 150 cottages and semi-detached houses, each containing an average of about six lights, which were erected some years ago near York. The services consisted of underground lead-covered and armoured cable.

Generally one service cable was made to serve two cottages, a loop being taken through the dividing wall by vulcanised indiarubber cable carried in enamel conduit. The junction between the main and service cable was made in an underground joint box. Each cottage was provided with a main switch and cut-outs, and most cottages had an electrolytic prepayment meter with an anti-vibration device, the whole forming a useful self-contained system worthy of any type of dwelling. As regards internal wiring the Henley twin metal sheath system was used throughout in conjunction with ordinary switches and ceiling roses. The cost of the wiring, including plain flexible pendants and switches, but no lamps or service connections, worked out at the time of the installation in 1914 at about 7s. 6d. per light. One of the arguments against these so-called cheap systems is that they are cheap only in capital cost, and that the high cost of maintenance is a set off to any gain in first cost. It is interesting to note that this has not been the experience with this particular installation, and that up to July, 1919, Messrs. Henleys inform us, the cost of maintenance has been nil, and no trouble or defect has been experienced on any of the wiring.

Fig. 2 shows a war-time installation, and is an example of the artisans' dwellings erected at Rosyth for the use of the Admiralty workmen. About 1,300 of these dwellings were built in blocks of two, four, five, six, seven, eight and twelve, each house containing either six or seven rooms, with one light per room. This work was carried out in 1917. The supply is from four-core mains on to which a two-core paper-insulated lead-covered and armoured service cable is jointed, a lead T-box being used for the purpose. In some cases one service is used for blocks up to five houses, and two services per block have five houses, but in other cases one service per block is used. The house supply is given through an armoured double-pole ironclad cut-out, whence wires are looped to each of the other houses, 3/20 flat twin rubber insulated metal sheath cables being used for the purpose. An interesting system of internal wiring is used in this case. Some of the houses are wired in series, and some in parallel, and no meters are installed. Where houses are wired in series, each is fitted with a condenser, a main switch of the coupled tumbler type and a pair of single-pole porcelain cut-outs. Where the houses are wired in parallel, ordinary switches and ceiling roses are used, and each house is fitted with auto coil, which reduces the pressure from 250 to 110 volts, an alternating-current current limiter, a coupled tumbler double pole switch, and a pair of single pole porcelain cut-outs. Supply for these houses is on a flat rate to the housing company, the tenant being charged 28s. per annum for the lighting of a six-roomed house, and 35s. per annum for a seven-roomed house. This charge is payable with the rent, and the tenant is allowed in addition two new lamps per year free, in exchange for the cap of a broken lamp. All other breakages are charged at cost price. We understand that the condensers referred to have been fitted as an experiment. Their function, like that of a current limiter, is automatically to reduce the pressure, and so to prevent waste by the lighting of an unnecessary number of lamps at one time.

Fig. 2.—Typical Artisans' Dwellings at Rosyth.

Lamps of different voltages have to be used with the condenser, so as to get the illumination desired, and a lamp to consume 60 watts has to be of a different voltage from that of a lamp consuming 20 watts. In those houses where condensers are used, a lamp switch is arranged across the lamp, so that the action of switching off the light short-circuits the lamp. The main switch is also arranged to short-circuit the installation at the consumer's side.

An interesting rural installation is shown in Fig. 3, which gives a view in the village of Barford, where 70 to 80 houses or cottages, together with the church and school, receive an electricity supply, all the buildings being wired on the Henley system. The current is derived from a water turbine set, driven by the River Avon, a gas engine being installed as a standby. This set also supplies the village of Sherbourne, which is about a mile away, and in order to get the pressure constant at the village end, an automatic booster is installed at the generating station. The roads of Barford are lighted from separate mains, controlled by an automatic switch at the station, a single cable being used for the feed and the return being carried through the earthed outer of the distributor. In these villages electricity is not only used for lighting, but for such agricultural purposes as milk separating, churning, wood pulping, kibbling, chaff cutting, while all the larger houses are fitted with electric pumping sets to assist in obtaining a necessary water supply.

Fig. 3.—The Village of Barford, where Henley's System is Used.

All this has been written by way of example, and we hope that those concerned with the development of housing schemes will profit by it.

Colour-matching by Natural and Artificial Light.

A discussion on the above subject was opened by Mr. L. C. Martin, of the Imperial College of Science, at the last meeting of the Illuminating Engineering Society. Mr. Martin, in the introductory portion of his Paper, explained the conditions which determine the apparent colour of an object, emphasising the marked difference in the distribution of light in the spectra of artificial illuminants as compared with daylight. The maximum of energy lies far out in the infra-red and there is, therefore, invariably an excess of red and orange rays in illuminants depending on incandescence and furnishing a continuous spectrum. Mr. Martin demonstrated the difference in the appearance of colours by natural and artificial light. Extreme instances are afforded by a fabric dye with a mixture of xylene blue and quinoline yellow, which is moss green by blue skylight, but in artificial light appears quite brown. Similarly a fabric dyed with benzyl violet and quinoline yellow matches dark navy blue in blue skylight, but is quite a dull red by artificial light.

Mr. Martin discussed in some detail methods of producing "artificial daylight" based on the use of special transmission screens with tungsten lamps. With the gas-filled lamps materially higher efficiencies have been obtained. Thus the efficiency of transmission with sunlight is stated to be 33 per cent., while for blue skylight it is about 14 per cent. Mr. Martin, however, finds that it is difficult, without extreme loss of light, to approach really near to the colour of daylight by transmission methods. Dyers generally prefer for colour-matching light from a blue sky, but this is a severe requirement and it is suggested that a compromise between sunlight and blue sky will in general answer. Another point of interest is the value of diffusion from an extensive source giving soft shadows. It appears that otherwise there is apt to be considerable direct reflection of white light which causes the colours to appear dim.

Mr. Martin then proceeded to describe the principles employed in the design of the Sheringham Daylight. It will be recalled that this device uses a large reflector placed above a gas-filled lamp, the lower half of which is covered by a reflector so that all light is directed upwards and diffusely reflected by the overhanging shade. The lower surface of this shade is covered by a mosaic of colours, so selected that the reflected light closely resembles daylight. Permanency of these colours is very important and for this reason ultra-marine, emerald green and a small amount of vermilion are preferred. The diffusion of the light is considered an advantage in many cases, for example in lighting picture galleries, and the overall efficiency, with a blue skylight unit, is estimated to be about 9 per cent. However, by modifying the colours, noon, sunlight or diffused daylight can be imitated, and in this case the efficiency would be materially greater.

In the discussion a communication from Prof. W. **Gardiner**, of the Bradford Technical College, who was responsible for a form of daylight lamp using the arc light, was presented. Prof. Gardiner contends that the alteration in colour of light, with age or voltage variation, on the part of glow lamps is a drawback—a point that was also raised by Dr. Crowley later in the discussion. Another written contribution, from Mr. M. **Luckiesh** in the United States, shows how widespread the use of "artificial daylight" units has become in the United States, these units utilising a transmission method, *i.e.*, achieving the desired coloration by the use of tinted glass.

Mr. A. E. **Bawtree** exhibited an apparatus for the analysis of colour, depending upon the combination of light from three apertures screened respectively with red, green and blue gelatines, the proportions of which could be varied. Mr. G. **Herbert** showed the Benjamin Daylight Unit, using the screen described by Dr. K. Mees before the Society in 1912, and remarked that the screen now shown was the same as that exhibited on the former occasion, and had been in constant use throughout this period. This showed the permanency of the colour. Miss F. E. **Baker** showed a form of lamp designed for use with Lovibond's tintometer.

Amongst others who spoke Mr. A. S. **Jennings** emphasised the importance of the subject from the decorator's standpoint, and pointed out the desirability of agreement on a standard "artificial daylight." He added that when this had been achieved it was also necessary to have a standard series of colour-tints with agreed nomenclature, so that any colour could be exactly reproduced and described. Dr. J. F. **Crowley** pointed out the importance of artificial daylight in the textile industry, where work was often suspended in periods when daylight was not available, or was abnormal owing to fogs, mist, &c. A comparison between the various systems of artificial daylight was much to be desired, and he would also like to see some demonstration of the effects of voltage variation and aging of incandescent lamps. Mr. R. **Sutcliffe** and Mr. W. **Wallace** described their experience in attempting to use artificial daylight for the matching of artificial eyes, and Mr. **Lamlough** referred to the precautions necessary in obtaining glass of satisfactory colour for transmission screens.

The **President**, in winding up the discussion, emphasised the desirability of selecting artificial lighting systems according to the work involved. In view of the great variations in daylight very great accuracy was not always needful.

Carbon Arcs for Searchlights.

In their reply to the discussion on this Paper which appears in the January issue of the "Journal" of the Institution of Electrical Engineers, Messrs. C. C. Paterson, J. W. T. Walsh, A. K. Taylor and W. Barnett make the following reply to a point raised by Mrs. Ayrton and commented upon in our editorial notes.

With regard to the extra light emitted in the case of a very short arc, we do not agree that this can be attributed to the tapering of the negative as the arc length is diminished. If we refer to Mrs. Ayrton's book, the diagram showing the shape of the negative at different arc lengths indicates clearly that for the 1 mm. and 2 mm. arcs the carbon diameters are, at equal distances from the crater, nowhere less in the former than in the latter, so that the amount of light obscured in the case of the 1 mm. arc must necessarily be greater than that obscured in the case of the 2 mm. arc, and though the relative amounts may, and probably will, not be exactly as given by the formula in our paper, yet it will be apparent that the light obscured by the negative of the 1 mm arc is greater than that obscured by the carbon of the 2 mm. arc.

The Ideal Home Exhibition at Olympia.

The whole electrical industry owes a debt of gratitude to the organisers of the Ideal Home Exhibition. As an indirect means of publicity for the advantages accruing from the use of electricity in the home it is the best that has ever been done, not forgetting the electrical exhibition of some years back. The very title of the exhibition helps, because people go there thinking of the home, so that the presence of electric lighting on nearly every stall, and the large number of other electrical domestic appliances cannot fail to have an effect. It is a pity that the exhibition is for London only, similar ones could be organised with advantage in the larger provincial towns.

In addition to lighting, the most conspicuous electrical exhibits were fires, cookers, table cooking accessories, irons, washing machines and vacuum cleaners galore. It will not only have an effect on those concerned with housing schemes, but also on the ordinary home dweller, and though there may be a time lag, the ultimate effect is bound to be an increased demand for electrical energy. It is unfortunate, therefore, that at the moment several supply authorities are suffering from a heavy peak load, and we hope that due consideration will be given by supply engineers so affected to the fact that domestic appliances, other than lighting, generally speaking, do not add to the peak load, but offer a valuable means of improving the domestic load factor. It would, indeed, be a fatal error to damp down new demands for electrical energy for domestic purposes.

In addition to the electrical exhibits, the engineer, and certainly the supply engineer, who is often called upon to work in close contact with the borough engineer or surveyor, will find much to interest him in the housing exhibits.

THE ALL-ELECTRIC HOUSE.

The centre of attraction seemed to be at the "Magnet" "all-electric house," shown by the GENERAL ELECTRIC COMPANY, LTD. Here we had to wait a few minutes in a queue. The reason really was that the excellent idea of conducted parties had been put into operation. a few persons at a time being admitted, and demonstrators in each room gave a short lecture, pointing out the advantages of the electrical fitments shown. This certainly drove home the message of electricity as far as possible. The entrance hall was fitted with two-way switching for light control and a hot-water radiator for warming purposes, and close to the hall door a cigar lighter was mounted. This seemed to be a thoroughly sound job, and likely to be free from the defects of fragility usually encountered with previous efforts at supplying an electric cigar lighter. The living room, in addition to being tastefully lighted both from a centre pendant shade fitting and a standard lamp, had displayed on the dining table a toaster, coffee percolator, plate-warmer, &c. A "Magnet" radiant fire emphasised the effect of comfort and ease which was indicated by the general appearance of the room. In the parlour we found an electrically-driven sewing machine, and in the bedroom electric fires were again in evidence, together with reminders of electrical convenience in the form of milk warmers, kettles, and bedside lights and switches. The bathroom was fitted with hot-water supply from electrically-heated storage tank in the drying cupboard in the scullery. In addition, electrically-heated towel rails and gown rails were fitted. The kitchen and scullery was where the jam occurred, because the women-folk were keen on the washing machine, electric range, irons, water boilers and the inevitable vacuum cleaner.

VICKERS, LTD.

Not far distant was the Vickers Ideal Cottage. This was of great interest, in that not only was it "all-electric," but it had been entirely constructed by Messrs. VICKERS, LTD. and their associated companies. The entire building was erected in ten days; the walls are of concrete, built up of standard concrete bricks, 9 in. by 4½ in. by 3 in., and made on the Vickers' portable brick machine. Concrete interlocking roofing tiles are employed in constructing the roof, and these tiles can be finished to any desired colour, though red is recommended as the cheapest and most suitable. The partitions are of Moles' fireproof partition bricks, made from the company's diatomaceous earth fields in Denmark. They are claimed to be sound proof and vermin proof, and possess the feature of affording a good holding for nails and screws. The floors are jointless, and covered with induroleum supplied by the associated firm of DOCKER BROS., LTD., who also supplied all paints, varnishes and distempers employed. Messrs. W. T. GLOVER & COMPANY, LTD., the cable manufacturers, who are now associated with Messrs. Vickers, Ltd., supplied all the cables and lead water piping, &c.

Naturally, electrical apparatus was in evidence in each room, either in the form of accessories, such as toasters, kettles, &c., or as main equipment in the kitchen as an electric range, water boiler, dish washer, clothes washer, completed by an electrically-driven Vickers' sewing machine. Even down to the toys in the front bedroom, the sporting gun in the hall, fenders and fireirons, were produced by the Vickers' group of companies. No better object lesson of the immense ramifications of this vast concern could have been provided.

BENJAMIN ELECTRIC COMPANY.

Still we have not disposed of the all-electric home. There was "Touch-a-Button House" attracting interest from the visitors. At first sight one might have taken the exhibit as a very fine display of tastefully selected antique furniture. Naturally the main item of attraction was the "Magicoal" Fire, which has already been described in these columns; though its real utility and advantage was, perhaps, better demonstrated in the spacious baronial hall exhibited in another part of the exhibition by Messrs. Harrods. In the kitchen of "Touch-a-Button House" was an electrically-driven machine for egg beating, potato peeling, knife sharpening, sausage making, and an ice cream refrigerator. In the centre was fixed an electrically-driven "washer-up," and also an electric range and water heater. Accessories in the form of coffee percolators, kettles, irons, &c., were also to be seen.

This concluded the "All-electric" house type of exhibit, but electrical exhibits are by no means disposed of.

CALLENDER'S CABLE & CONSTRUCTION COMPANY, LTD.

Messrs. CALLENDER'S CABLE & CONSTRUCTION COMPANY, LTD., had arranged their stand in two portions to represent two distinct types of mural decoration, and displayed to advantage the "Kaleeco" wiring system. Now that labour has risen to such abnormal cost, if electricity is to be adopted with housing schemes every possible means will have to be adopted to keep the cost down, and the "Kaleeco" wiring system (Fig. 1) offers facilities for easy installation. Although the cost of installing this system is small, it is in every way a workmanlike job, and complies with the I.E.E. Wiring Rules. A patented junction box, which can be converted to a "straight-through," tee or four-way box, is an interesting feature of the system. The box and fittings are made automatically by machinery, thus ensuring interchangeability of parts. The cable is made in three types, single, twin and three-core, of which the single cable is circular in section, and the twin and three-core cables are of rectangular section. The outer dimensions of even the three-core cable are small, and it looks quite unobtrusive when fixed, much less unobtrusive than the surface-fixed casing or tube. The conductors are tinned copper wires, insulated with two layers of vulcanised indiarubber, taped, and then vulcanised, and finally sheathed under pressure with a tube of flexible metal, which provides adequate protection against mechanical damage. Sagging does not occur between clips, provided they are properly spaced. An additional advantage is that the "Kaleeco" junction box permits the cable to be brought in in any position.

FIG 1.

BRITISH ELECTRIC TRANSFORMER COMPANY.

The BRITISH ELECTRIC TRANSFORMER COMPANY, LTD., had a representative display of "Tricity" Cookers and Flamingo Fires. The "Tricity" oven is now black with nickel facings and has a slagged wool lagging, and six elements are fitted consuming 250 watts each, two being fixed at the top and four at the bottom, adequate heat control being provided by rotary semi-parallel switches. Grills, boiling plates and a cake oven, all of new designs, were also displayed.

QUEAD, LTD.

A novelty at the stand of Messrs. QUEAD, LTD., was an electric iron provided with heat control, four plug pins being mounted on the top of the iron just behind the handle. A four-way connector used in conjunction with the plug pins yielding low, medium, high, or point heat on the iron. This latter is a decided advantage because for light lace work it is often necessary to have additional heat at the point of the iron, whilst heat is not particularly required at the back end. Further, a hotter iron is required for large work, such as sheets, than is necessary for light work like blouses, because the one holds more moisture than the latter. The Quead iron weighs 5 lb., a suitable weight for general purposes; and the advantage of heat control will certainly appeal to many housewives. The handle is designed to be lower than the majority of handles, giving a better grip and more power over the iron, yet the nuts holding the handle to the iron do not bark the knuckles. A spring clip attached to the back end of the iron provides a means of standing the iron on end, thus removing the necessity for an iron stand. A new rectangular radiant hotplate was also exhibited by this firm, and heat control was provided for in the same way. The Quead soldering iron is another new device which shows care and forethought in design. The difficulty of balance has been overcome. It can be held in the hand comfortably without feeling a weight or dragging of the top end downward. In addition to general purposes such irons should prove eminently useful in connection with armature winding, soldering connections on telephone switchboards, &c.

Filbar Electric Heater Company.

The **Filbar Electric Heater Company, Ltd.**, were showing an interesting hot-water water heater for attachment to any existing water tap. The heater element is automatically switched on when the water tap is turned on, and it is impossible to put the element on circuit unless water is flowing into the apparatus. Some automatically-controlled electric sterilisers were also shown. In these it is impossible for the element to be on circuit after the water falls below a predetermined level. A small pilot lamp indicates when the steriliser is on circuit, and one charge of water lasts for a period of about four hours.

In addition to oil engine-driven complete electric lighting sets, Messrs. **Strode & Company, Ltd.**, were displaying various self-contained electric cooking utensils and electric light fittings.

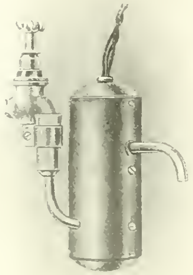

Fig. 2.—Filbar Water Heater.

Other Interesting Exhibits.

Electric lighting plants were also exhibited by **R. A. Lister & Company, Ltd.**, **Arthur Lyon & Wrench**, **Austin Motor Company, Ltd.**, **Aster Engineering Company, Ltd.**, whilst Messrs. **Studebaker Ltd.**, exhibited the Lalley light plant. These plants were similar to the ones shown at the recent Shipping and Engineering Exhibition at Olympia, and were described in our columns at that time.

The "Iowa" **Engineering Company, Ltd.**, were displaying a range-dimming switch suitable for single or multiple lights and made either in the form of an enlarged tumbler switch for wall mounting, or as a hanging pendant attachment.

Electric cookers and radiators were to be found amongst the collective exhibits of the **Falkirk Iron Company, Ltd.**, which comprised all types of domestic heating appliances.

Siemens Brothers & Company, Ltd., practically confined their display to a tastefully decorated room showing lighting fittings wired up with the "Stannos" system of wiring, which essentially comprises a double or triple core cable rubber insulated, and armoured with a flexible metal covering.

Radiant electricity as a curative treatment was dealt with adequately at Messrs. **Dowsing Radiant Heat Company's** Stand, and in addition were shown kettles, irons, toasters, &c.

The **Carron Company** displayed a most pleasing collection of fireplace suites and a selection of electric heaters.

The display of British made apparatus by **Belling & Company** was evidence that this firm is continuing to make a bold bid to hold the market against American competition. The exhibit comprised the Belling Modernette Range, an electric cooker of sheet steel construction mounted on legs which raise the oven to a convenient height, and therefore avoids stooping. A full range of Belling table accessories was also shown, together with an electric washing machine and an electric sweeper. A Belling bath water heater effectively completed the range of domestic equipment shown.

Bastian Electric Company, Ltd., devoted main attention to the Bastian radiant electric fires and the Bastian hot water heater for bathrooms.

In the gallery, entitled the **Labour-Saving Section**, we encountered a veritable battery of vacuum cleaners and electric dish and clothes washers. In fact every other stand seemed to contain a vacuum cleaner or dish washer, and the remainder seemed mainly concerned with kitchen cabinets and utensils.

L. C. Hawkins & Company had a full range of their well-known "Universal" series of domestic electrical appliances for table use, a "Polliwashup," a geyser electric washer, &c.

Benham & Sons, Ltd., were also in the gallery displaying their electro-vapour radiators and domestic cooking appliances together with an electric range.

America was again in evidence at **Duncan Watson & Company's** Stand, where we found Hughes cookers, dish-washing machines, wringers, together with a good show of smaller accessories and a complete generating set for country houses.

The "Thor" electric washer (Fig. 3) was exhibited by **Chas. E. Beck, Ltd.**, but on their ironer we were sorry to see gas employed as the heating medium. Messrs. **Harrods'** display of "Pyrex" transparent ovenware seemed to be distinctly in keeping with electric cooking, and we would commend supply authorities to consider using this ware in connection with cooking demonstrations.

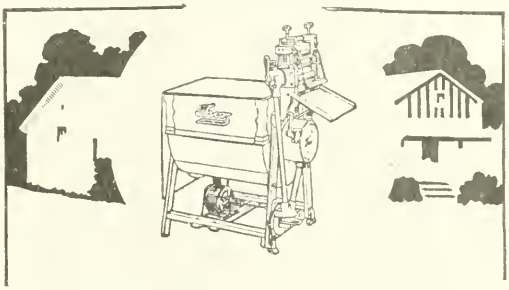

Fig. 3.—View of "Thor" Electric Washer.

Small electric motors for sewing machines, egg whisks, drink mixers, &c., were the striking feature of the exhibit by **S. C. Leach & Company, Ltd.**, and a separate portion of the stand was given over to the demonstration of Violet Ray Treatment.

The Autoplant, which is extensively used for private electric lighting, is also to be seen at the exhibition. The distinguishing feature claimed for this electric generator is that it requires no attention, for its $1\frac{3}{4}$ h.p. petrol engine is automatically started when the storage battery needs re-charging, and stops when the battery is fully charged. Owing to the ingenious design of the machine, the variations in voltage essential to correct charging are made automatically, while a constant voltage is maintained for the lighting. The generator is suitable for installations up to 800 c.p. with 25 volt metal filament lamps. The Autoplant is made by the **Austin Motor Company, Ltd.**, makers of the well-known "Austin Twenty" car.

General Survey.

Much of the apparatus mentioned, heating and cooking apparatus in particular, has already been described in our columns, and therefore space has not been devoted to a lengthy repetition. We entered the exhibition hoping that electricity would make a dominating show; the four-page advertisement of the B.C.G.A. in the catalogue damped our feelings a bit at the start, for the E.D.A. had only half a page; but we left the exhibition feeling that our hopes for the dominance of electricity had been amply realised. The ideal home now means the inclusion of electricity as the ideal lighting, heating and power agent.

We were convinced that serious attempts were being made to design houses for the working and lower middle classes which, beside being more comfortable and easier to work, would be more inspiring in appearance, and more inclined to cause the inhabitants to take a pride in their home. We shudder to think of the mid-Victorian efforts of streets of similar houses, dingy, dark and cramped.

Views of the Visitors.

By listening to conversations on the various stands we rather strengthened our opinion that the appeal on behalf of electricity has got to be made to women. It was the women who asked numberless questions regarding kitchen equipment, radiators, cookers, &c. The woman who takes a practical interest in the home. Labour-saving and cleanliness appeal direct to her, and only indirectly to the man, because he does not do the work. The man's viewpoint of a home is more æsthetic, hence we find him more attracted in the furniture and decorative section. Failing the organisation of an electrical exhibition at Olympia nothing more effective than the dominance of electricity at the Ideal Home Exhibition could have been hoped for. The exhibition remains open from 10 a.m. to 10 p.m. each day until February 25th, and is well worth a visit.

(To be concluded).

Sir Robert Hadfield on the Work of Michael Faraday.*

The Faraday Society owed its origin in 1902, chiefly to a little band of workers who met together to advance the great cause of scientific knowledge. It was founded on February 1st, 1903, at a meeting in the rooms of the now defunct Faraday Club, held at St. Ermin's Hotel, Westminster. Amongst its founders were Mr. Sherard Cowper-Coles, Mr. W. R. Cooper, Prof. F. G. Donnan, Dr. F. M. Perkin, Mr. Alexander Siemens, Mr. James Swinburne, and Mr. F. S. Spiers, our present secretary, to whom we owe a deep debt of gratitude for his indefatigable work on behalf of our society, and to whom there should be accorded a crown of laurels. To each of these founders I have sent a special invitation asking them to be present this evening. Our first president was Sir Joseph Swan, F.R.S., followed by Lord Kelvin, Sir William Perkin, F.R.S., Sir Oliver Lodge, F.R.S., Mr. J. Swinburne, F.R.S., and Sir R. T. Glazebrook, F.R.S. The objects of the society as originally defined were to promote the study of electrochemistry, electrometallurgy, physical chemistry, metallography, and kindred subjects.

Nitrogen Products Committee.

I will refer to one subject in which we gave a helping hand during the war—in fact, it might be said that the Faraday Society originated this special research in this country, namely, that relating to nitrogen products, which mainly through our suggestion was taken up by the Munitions Inventions Board. My friend, Prof. Huntington, worked in season and out of season to get the Government Department concerned interested. He finally succeeded in persuading the Munitions Inventions Department to appoint a Special Nitrogen Products Committee, who in their turn were instrumental in establishing a Research Department. As Mr. H. W. Dickinson, secretary of the M.I.D., points out, so much spade work was done by the department with regard to this subject that when at a later date owing to the submarine campaign the policy of the Ministry changed and it was decided to go to new sources for nitrogen supply, the results of the research work and of the information gathered by the Research Department mentioned were ready to hand and enabled practical work on a large experimental scale to be commenced at once. It should be added that the work was taken up for the committee by one of our members of council, Dr. J. A. Harker, F.R.S., who was allowed by the National Physical Laboratory to assist in this important development, his labours being of the highest value. The country is greatly indebted to him for the untiring devotion he has shown in working out this special and important subject to a successful issue. Our council hope that before long they will be able to present a report to us describing in detail the work carried out. The report of the committee itself is shortly to be published,† and it will probably be one of the most remarkable documents in regard both to scope and matter that has been issued by a Government department during those troublous times. The work done, although not immediately made use of for war purposes, as the armistice rendered any help needless in this quarter, will, without doubt, bear great fruit in the future; in fact, the nitrogen factory, which was being started during the war, has already been taken over by a private organisation. It is therefore probable that the nitric acid required in this country for making explosives, dyes and drugs will be produced synthetically in this manner.

Summary of Faraday's Work.

Turning now for a moment to Michael Faraday, from whom our society takes its name, De la Rive, the well-known French scientist in his "Notice on Faraday's Life and Work," Archives des Sciences de la Bibliothèque Universelle, October, 1867, stated that the number of Faraday's Memoirs from 1820 to 1855, all of these important, was almost incredible.

Faraday was born at Newington Butts on September 22, 1791, and finally passed away at Hampton Court on August 25, 1867. Tyndall said that it seemed desirable to give the world some image of Michael Faraday as a scientific investigator and discoverer. He regarded the attempt to respond to this desire, whilst a labour of difficulty in adequately presenting a history of this great man, as also a labour of love. However well acquainted he might be with the researches and discoveries of the great master—however numerous the illustrations which occur to him of the loftiness of Faraday's character and the beauty of his life—still to grasp him and his researches as a whole; to seize upon the ideas which guided him and connect them; to gain entrance into that strong and active brain and read from it the riddle of the world—was a work not easy of performance. As he was a believer in the general truth of the doctrine of hereditary transmission, Tyndall, who shared the opinion of Carlyle that a really able man never proceeded from entirely stupid parents, said that he once used the privilege of his intimacy with Faraday to ask him whether his parents showed any signs of unusual ability. He could remember none. His father was a great sufferer during the later years of his life, and this might have masked whatever intellectual power he possessed. When thirteen years old, that is to say in 1804, Faraday was apprenticed to a bookbinder in Blandford-street, Manchester-square; here he spent eight years of his life, after which he worked as a journeyman elsewhere.

Faraday was only 22 years of age when he obtained a position in the Royal Institution. His first contribution to science appeared in the "Journal" of the Royal Institution in 1816, that is, in the publication known as the "Quarterly Journal of Science." I thought it might be of interest to give the following summaries by Tyndall of (1) Researches by Faraday, and (2) Discoveries by Faraday:—

Researches by Faraday.

	Published
First contribution to Science—Analysis of Caustic Lime from Tuscany	1816
Experiments on Sounding Flames	1818
Vaporisation of Mercury at Ordinary Temperatures	1821
On the Limits of Vaporisation	—
Experiments on Alloys of Steel	—
Vibrating Surfaces	1829
On the Quantitative Comparison of different forms of Electricity	1833
On the Absolute Quantity of Electricity associated with the particles or Atoms of Matter	—
The Power of Metals and other Solids to induce the combination of gaseous Bodies	—
Extra Current—The influence by induction of an Electric Current upon itself	1835
On Frictional Electricity, Induction, Conduction, Specific Conductive Capacity, and Theory of Contiguous Particles	1835 to 1838
Further Researches on Liquefaction of Gases—Establishing the fact that Gases are vapours of Liquids possessing very low boiling points	1844
Speculations on the Nature of Matter and Lines of Force	1846
On the Diamagnetic Condition of Flame and Gases	1847
On Magne-Crystallic Action and Lines of Force	1848 to 1851
Magnetism of Gases	1850
Atmospheric Magnetism	—
Electricity of Gymnotus	—
Source of Power of the Hydro Electric Machine	—
Regelation	—

Discoveries by Faraday.

	Published
Two new Compounds—Chlorine, Carbon and Iodine: Carbon and Hydrogen	1820
Alloys of Steel	1821
Magnetic Rotations	—
Liquefaction of Gases	1823
Change of colour of Glass in Sunlight	1825
New Compounds of Hydrogen and Carbon	1825
Benzol	—
Improvements in manufacture of Glass for Optical purposes. Afterwards the foundation of most important Discoveries, *e.g.*, Magnetisation of Light	1829
Peculiar class of optical deceptions—optical toy, the Chromotrope owed its origin to this	—
Magneto-Electric Induction—Tyndall says: "Greatest experimental result ever obtained by an investigator. The 'Mont Blanc' of Faraday's achievements"	—
Terrestrial Magneto Electric Induction	—
Identities of Electricities—Static, Voltaic, Magneto, Thermo, &c.	1833
New Law of Electric Induction	—
Laws of Electro-Chemical Decomposition—Definite Electro-Chemical Decomposition. Tyndall says: "This Law ranks in importance with that of the Definite Combining Proportions in Chemistry"	—
Origin of Power in the Voltaic Pile	1834
Magnetisation of Light and the Illumination of the Lines of Magnetic Force. In other words, the Rotation of the Plane of Polarisation	1845
Diamagnetism or the Magnetic Condition of all Matter	—
Atmospheric Magnetism	1850

I will also quote Tyndall's Summary of Faraday's work somewhat fully, as it is indeed worth reading. It is a stimulus to each of us according to his light to go and try to do likewise, even if in a smaller and humbler way.

Tyndall says: "When from an Alpine height the eye of the climber ranges over the mountains he finds that for the most part they resolve themselves into direct groups, each consisting of a dominant mass surrounded by peaks of lesser elevation. The power which lifted the mightier eminences, in nearly all cases, lifted others to an almost equal height. And so it is with the discoveries of Faraday. As a general rule, the dominant result does not stand alone, but forms the culminating point of a vast and varied mass of inquiry. In this way, round about his great discovery of magneto-electric induction, other weighty labours grouped themselves. His investigations on the extra current; on the polar and other conditions of diamagnetic bodies; on lines of magnetic force, their definite character and distribution; on the employment of the induced magneto-electric current as a measure and test of magnetic action; on the repulsive phenomena of the magnetic field, are all, notwithstanding the diversity of title, researches in the domain of magneto-electric induction. Faraday's second group of researches and discoveries embraced the chemical phenomena of the current. The dominant result here is the great law of definite electro-chemical decomposition, around which are massed various researches on electro-chemical conduction, and on electrolysis both with the machine and with the pile. To this group also belong his analysis of the contact theory; his inquiries as to the source of voltaic electricity, and his final development of the chemical theory of the voltaic pile. His third great discovery is the magnetisation of light, which may be likened to the Weisshorn among mountains—high, beautiful, and alone. The dominant result of his fourth group of researches is the discovery of diamagnetism, announced in his memoir as the magnetic condition of all matter, round which are grouped his inquiries on the magnetism of flame and gases; on magno-crystallic action, and on atmospheric magnetism, in its relation to the annual and diurnal variation of the needle, the full significance of which is still to be shown. These are Faraday's most massive discoveries, and upon them his fame must mainly rest. But even without them, sufficient would remain to secure for him a high and lasting scientific reputation. We should still have his researches on the liquefaction of gases; on frictional electricity; on the electricity of the gymnotus; on the source of power in the hydro-electric machine; on the electro magnetic rotations; on regelation; all his more purely chemical researches, including his discovery of benzol. Besides these he published a multitude of minor Papers, most of which in the same way illustrate his genius."

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* Abstract of an address delivered at a joint meeting of the Faraday Society, Royal Microscopical Society, Optical Society and Photomicrographic Society.

† See The Electrician, Jan. 23rd, 1920, p. 82.

Tyndall adds that no allusion is here made to his power as a lecturer. Taking him all in all, it will be conceded that Michael Faraday was probably the greatest experimental philosopher the world has ever seen. The progress of future research will tend not to dim or diminish, but to enhance and glorify the labours of this mighty investigator.

Speaking with regard to my own lines of research, as representing the Faculty of Metallurgy, I may mention that Faraday, in his experiments on alloys of iron with other elements, in other words, the production of alloy steel, carried out in 1821 and 1822, showed that a remarkable inspiration evidently existed in his mind as to the great future this line of research work presented. Singular to say, it is just about 100 years ago that Faraday wrote several letters from the Royal Institution (in April and June, 1820), to his Swiss friend De la Rive, Professor of Chemistry, Geneva, in which he gave an account of some experiments on steel made by himself and Stodart. The world's great technical advances during the last thirty years have been—and I say it unhesitatingly—in a large measure due to the introduction of alloy steels such as Faraday had in mind. As already mentioned, Faraday, with Stodart, started these researches at the Royal Institution, finally completing the experiments by sending his various mixtures to be melted at the Sanderson Works in Sheffield, this firm being still in existence to-day. The specimens had to be sent by coach, the work being given to a trusty assistant who had to go down and see the experiments put in hand and completed. Beyond the work of Mushet this particular land of research lay fallow for many years; in fact, it was my own discovery and invention of manganese steel in 1882 which showed that the new world already indicated by Faraday was there ready to be explored. This exploration has rapidly taken place during the last thirty years, including the discovery and invention of chromium steel, silicon steel, nickel steel, tungsten steel, high-speed tool steel, non-corroding and many other types of steels. Almost as important was the fact that alloy steel necessitated special heat treatment, which again required and called for the use of scientific methods for the determination of temperatures, critical points, microstructure study, improved analytical methods, mechanical testing, hardness determination, observation of electrical conductivity, magnetic susceptibility, electrical resistance, hysteresis effects and other qualities.

The Society is indeed honoured in being allowed to bear the name of so great a man as Faraday, whose work is still benefiting our Empire.

Review.

Notes on Magnetism for the Use of Students of Electrical Engineering. By G. C. Lamb, M.A. (London: Cambridge University Press.) Pp. viii. + 94. 5s. net.

This is a very useful compilation of notes on magnetic theory, and its application to the measurement of the magnetic properties of iron and its various alloys. Although primarily intended for the use of students in the Engineering Laboratory at Cambridge, it is a book which should be in the hands of all students of electrical engineering and workers in magnetic measurements. The first part of the notes is concerned with magnetic fields and forces, electro-magnetic induction, and the measurement of the quantity of electricity induced in a circuit due to change of magnetic linkages. The theory of the moving-coil galvanometer is dealt with, and the remainder of the book deals mainly with various methods of iron testing and the influence of temperature, composition, eddy currents, &c., on the magnetic cycle.

Useful references are given to various books and papers. The book bridges a gap between the meagre description of magnetic work usually found in a text book on electrical engineering, and the larger, specialised text books on magnetic testing in a very able manner.

Although admittedly limited in scope, it would be an advantage to students if more methods for the important operation of calibrating the galvanometer for the measurement of flux, were given, such as the Hibbert Magnetic Standard, the Earth Inductor, the Duddell Inductor, the Condenser, &c. The Standard Field described would be more useful if it were wound on a split brass tube, as it could then be used for the calibration of search coils, especially small annular coils for the measurement of H (as described in Note 36), in conjunction with the Campbell Variable Mutual Inductance Standard, a very sensitive null method resulting using alternating current, or a secohmmeter.

The book is got up in the usual good style of the Cambridge University Press, and the diagrams are very good; but for the use of students, a stouter cover is desirable, and the price for 94 pages seems rather high.

H. F. Haworth.

Correspondence.

AN ARTIFICIAL TRACK CIRCUIT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to Mr. Gall's article on "A.C. Track Circuits" in your issue of September 5, 1919, will you please obtain the following particulars from the author as I am unable to understand them.

In No. 2 diagram $PL\,\frac{r_r}{3^2{}_r}$ is mentioned. Is this same as shown elsewhere as $Z^2{}_r$, viz., that Z_r is to be squared?

On p. 215 it is stated "it is convenient to *extend* (? relay) voltage P_R to the necessary value P_L at leak," but surely this does not mean that the voltage at the relay is the same at centre of track circuit? A little lower on same page it states the combined added impedance of Z_R and Z_r to the centre point of the track = 0·803 ohms, but above it states rail (? and relay) impedance $= Z_n = \frac{P^2}{I_n} = 0{\cdot}835$ ohms. Should not these two be the same?

Fig. 3 appears to have been cut off too soon. Should it not show the impedance circuit complete by including the relay? The same remark seems to apply to Fig. 5.

The last formula on page 215 states rail admittance $Y_o = 1{\cdot}2$ mhos. Is this correct? Presumably it is meant for combined rail and relay admittance.

In Fig. 1 it is stated that the simple rail impedance = 3 (? termed Z_r elsewhere). How is this obtained?

Having spent a great amount of time over this article I should feel obliged if these questions could be answered so that further effort might be made to accomplish some part of this subject a little more satisfactorily than I can do at present. I am, &c., F. Bourne.

London, S.E., Feb. 2.

We have submitted Mr. Bourne's letter to Mr. Gall and have received the following reply:—

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am sorry that Mr. Bourne has found a little difficulty over the points raised, and I will endeavour to make them clearer. One of the chief misunderstandings has arisen from the confusion between capitals given to the complex values of impedance and admittance and the italics denoting their absolute values. The complex value of the rail-impedance is given as Z_r while the absolute value is given as $\mathfrak{Z}_r$. That is to say $Z_r = r_r + jx_r$, which is a complex quantity, and $\mathfrak{Z}_r = \sqrt{r_r^2 + x_r^2}$, which is a numerical quantity.

From this it follows that the value used in Fig. 2.

$$P\frac{x_r}{\mathfrak{Z}_r^2} = P\frac{x_r}{r_r^2 + x_r^2},$$

where x_r is the rail reactance in ohms, r_r the rail resistance in ohms, and $\mathfrak{Z}_r$ is the resultant rail impedance. In the text the value given is

$$P_L\frac{x_r}{Z_r^2} = P_L\frac{x_r}{r_r^2 - j^2x_r^2} = P_L\frac{x_r}{r_r^2 + x_r^2} \text{ (since } j = \sqrt{-1}\text{)}.$$

which is the same as the above.

In extending the voltage to the leak, instead of considering that at the relay, the rail impedance is most certainly included so that the relay is considered as being at the leak, but having its impedance increased by the rail impedance up to that point, or of a value $Z_R + Z_r$ which has been called it will be noticed Z_{Rr}, equal numerically to 0·803 ohms.

With regard to those designated as "rail-circuit" values of impedance and admittance, these in every case include everything in the external rail circuit, rails, ballast and relay representing the combined values of impedance or admittance as would be measured at the feed-end of the "track circuit" with the supply disconnected. The suffix a is used to denote quantities at this point. This should make clear the meaning of Z_a, Y_a and I_a which have been queried, and it is this Z_a which is numerically equal to 0·835 ohms.

By combining everything in the external circuit into the values of Z_a or Y_a the various constants of rails, ballast and relay need not enter into the calculation when considering effects at the feet end. This is why Figs. 3 and 5 are not extended beyond the value $\mathfrak{Z}_a$, which includes everything beyond that point.

In anticipation I would point out the slight intermingling of type which has occurred in this article. The letter P used to denote points under discussion in the diagrams has been printed in the same type as that denoting pressure in the calculations. I am, &c., Douglas C. Gall.

London, Feb. 1.

FOWLER'S BATTERY RULES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I quite expected that most of this year's electrical pocket-books would still be giving a bad rule for battery arrangement; but I am surprised to find that Fowler's is giving two—one bad and the other worse.

On p. 258 of this Electrical Engineer's Pocket Book we are first told that we shall get the maximum current obtainable from an arrangement of N cells in p parallel rows each containing s cells in series, if we choose s so that rs/p (the resistance of the battery) is most nearly equal to R (the resistance of the external circuit). I am employing the usual letter symbols instead of those in this book so that your readers may follow the argument more easily.

The second rule (on the same page) tells us that we shall get maximum current when $s = \sqrt{NR/r}$. Presumably, the sign of equality here signifies the same as the words "most nearly equal" that were used in stating the first rule: if it meant that s was to be absolutely equal to the square root indicated, the rule would be absolutely useless. Besides, it is this second rule (read in the way that I presume is intended) that will most frequently give the maximum current, and the following example shows that it will sometimes give much more than twice the current obtainable with the first rule.

Suppose we have $N = 26$, $r = 1$ and $R = 3$. It will be found that the first rule tells us to make $s = 2$, whereas the second rule tells us to make $s = 13$, which increases the current by about 116 per cent. But if we now change R from 3 to 2, both of these rules will tell us to make $s = 2$, giving a current that will be increased by more than 61 per cent. if we make $s = 13$. Even the second rule, then, will sometimes fail very badly; but in the following paragraph I prove a rule that will be seen to be perfectly reliable.

In every case the current will be

$$C = \frac{es}{R + rs/p} = \frac{esp/R}{p + rs/R},$$

where e is the E.M.F. of each cell and r is the resistance of each. But esp/R is constant, sp being the given number of cells; and from this it is evident that C will be greatest when $p + rs/R$ is smallest, or when $p + sk$ is smallest if we use k to represent the constant r/R. Further, we shall have the smallest value of $p + sk$ when we have the numerically smallest value of $p - sk$; for

$$(p + sk)^2 = (p - sk)^2 + 4psk,$$

where $4psk$ is constant, since ps is constant. This shows that we shall always get the greatest current that is possible under the conditions laid down if we make p most nearly equal to sk.

But it may happen (though most writers appear to have overlooked this possibility) that the current can be increased by reducing the number of cells. Consider, for example, the above-mentioned case of 26 cells with $k = 1/3$. The application of my rule tells us to make $p = 2$, so that $sk = 13/3$. Here p is much below sk; but the next higher value that we can take for p is 13, which is above the present value of sk. Therefore (since the product of p and sk is constant) this change in the value of p would give us a new value of sk that would be below the former value of p; that is to say, the difference between p and sk would be greater than before, and the current would consequently be smaller. But if each of our so-called cells really consisted of a battery of three cells in series (the sort of thing we have in certain "high-voltage cells"), we could get a decidedly greater current by making $p = 3$, for this would give us $s = 26/3$, so that $sk = 26/9$, which is much nearer to 3 than 13/3 is to 2. This suggests that we might get a greater current by reducing our 26 cells to 24, so that an arrangement with $p = 3$ would be possible; and it will be found that we do get a slightly greater current in this way. We are thus led to the following supplementary rule: If it is possible to increase the current by reducing the number of cells, the smaller number will have a factor between the p and the sk that give the greatest current with the full number. I am, &c.,

Newcastle-on-Tyne, Feb. 1. W. F. Dunton.

PULVERIZED COAL FOR LOCOMOTIVES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In a recent number of the "Engineer" reference is made to the Fuller locomotive equipment now being tried out on the Lehigh Valley Railway of America.

It might interest your readers to know that a similar equipment has been recently supplied for use on the New South Wales Government Railway, and that complete coal pulverising plant with engine equipments are now on order for the Netherland State Railways and the Italian State Railways. The latter plant is to demonstrate the practicability of firing Italian lignite, of which there are considerable quantities in place of imported and expensive high-grade coal.

An economy equal to one-third of the coal as hand fired on locomotives can be guaranteed, fuel savings by this means running up to 40 per cent. in many cases. In addition to actual fuel economy, pulverised coal firing effects smokeless operation, increases the tractive power of locomotives and eliminates all expense for hand firing tools. Pulverised coal and colloidal fuels are destined to become widely adopted for locomotive firing, more especially in countries where coal for this purpose now costs £8 to £10 per ton. I am, &c.,

London, Feb. 9. L. C. Harvey.

The Electrician.
FRIDAY, FEBRUARY 13th, 1920.
Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). Telegrams: "Benbrotric Fleet London."

The Technical Development of Telegraphy since 1870.

The jubilee of State ownership of the telegraphs of this country which occurred on February 5th affords an opportunity for reviewing the state of the telegraphic art under the guidance of the British Telegraph Administration.

Very soon after taking possession we find a process of unification setting in, and a few years later the single needle had been relegated to unimportant circuits. The medium traffic circuits were worked by the Morse sounder with, later, the duplex balance added; and the arterial connections were operated by the Wheatstone automatic system. The Morse quadruplex which reached commercial importance in America, was also introduced and is still largely used.

The Wheatstone Automatic System.

The monument to the skill and perseverance of the Post Office Telegraph Engineers will always be found in the gradual improvement effected in the Wheatstone automatic system. The mechanical improvements in the transmitting apparatus made by the late Augustus Stroh and his band of craftsmen at what is now the famous Holloway Factory, contributed to no small extent to increasing the attainable speed from 80 to 400 and, subsequently, to 600 words per minute. But it is not by the apparatus alone that the remarkable performances of the Wheatstone system have been attained. The introduction of the resistance-condenser arrangement due to Maxwell when placed in series with receiver had a marked influence on the transmission possibilities of the combination of apparatus and line circuit.

The subdivision of long and difficult circuits by repeaters, thus increasing the transmission speeds, by reduction of the KR factor; the improvements in the repeaters themselves by the substitution of direct repeating from the repeating relays for older methods; refinements in balancing on duplex circuits—all these played a contributory part in the remarkable progress of this system in the hands of the State. The Wheatstone system has always been a characteristic of the British Telegraph Service, and with it the unique method of news distribution has been handled for many years. Typewriter pattern perforators and the ingenious Morse code printer of Creed are a later development, due to outsiders, but the backbone of all is the work of dead and unnamed Post Office Engineers. We well remember the early American quadruplex apparatus, long since swept away and replaced by the well-designed, well-made and, by comparison, simple British apparatus.

The Hughes Printing Telegraph.

The acquisition of the Submarine Telegraph Company with its system of Continental cables brought the Hughes type-printing telegraph into use. We have no record of a revolution in design of this equipment, as the Hughes apparatus by this time seems to have reached finality. But yet there is one achievement to be noted, viz., the application of the duplex balance to the Hughes system. The entry of the Hughes apparatus and the direct connection prevailing at the time of the handing over of the telegraph to the State between the French and British Telegraph Engineers brought the Baudot multiple printing system to the front, and a good deal of the traffic on important lines in this country is now conducted on this system. The Baudot system as used here remains in principle the same as the French pattern, but we use the duplex balance and double the traffic carrying capacity of the line. The London to Birmingham wire is worked sextuple-duplex, *i.e.* six traffic channels in each direction on one wire.

Among other improvements during the time the telegraphs have been owned by the State may be mentioned the extensive use of secondary cells; fire-proof methods of cabling in offices; the concentration of numbers of unimportant radiating circuits on switchboards; telegraphic intercommunication of radiating circuits through a central switch, obviating re-transmission; and central battery methods of operating medium traffic circuits, reducing the out-office circuit equipment to a key, Vyle polarised sounder and a condenser.

The British telegraph system is one which can safely be held up as a model, and all manufacturers are familiar with the legend "latest Post Office practice" on foreign or Colonial inquiries.

The Ascribing of Credit.

It is a difficult task to assign credit to individuals, but in dealing with telegraph progress in the British service one is irresistibly reminded of J. B. Chapman, J. Chapman, M. Walker, now deceased, C. C. Vyle, John Gavey and W. Slingo, who are still happily with us, all of whom may be looked upon as the Old Guard; while later we have R. Hendrie, T. F. Purves, R. Mercer and A. C. Booth, their successors.

Financial Aspects.

One can almost see the man in the street scornfully smiling after reading this record and repeating the oft-spoken sentence, "The telegraphs don't pay." Without discussing the differences between a Government Department which exists to give service and a private company whose object is to make dividends, there is one contributory cause to the unsatisfactory financial aspect of British telegraphy, a cause which is beyond the powers of master minds to move. An inland telegraph system such as ours where no great differences in time exist between the remotest offices has a peak load of maximum traffic and many hours where the costly plant is not utilised. A trans-continental system, on the other hand, has its traffic in one direction during one part of the 24 hours and in the other direction at another part. A partial overlap may occur when traffic is passing in both directions, but the long stretches when no traffic is passing in one direction or the other can be utilised for sending deferred rate messages. In this country the deferred rate telegram would hardly be quicker than a letter, while it would be, of course, much dearer. A deferred rate message across a continent would beat the mail and has advantages which counterbalance its cost, while the introduction of this traffic results in a much more satisfactory utilisation of plant.

Pacific Cable Board.

The accounts for the year ended March 31, 1919, together with the report of the Board have been issued. The traffic receipts were £554,512 (against £401,975 in 1917-18), and total revenue was £564,097 (£411,162). Total expenditure was £467,823 (£389,899), including £6,569 head office expenses, £150,661 for cable stations, £25,277 ship (salaries and expenses), £50,000 for suspense account and £232 placed to reserve and renewal fund. The balance was £96,276, against £46,653. In view of future contingencies, it has been thought advisable to employ part of the exceptional receipts of the year in further strengthening the reserve and renewal fund by a contribution of £180,000 (in addition to the normal payment of £30,000), to appropriate £18,000 to the fund on account of the schooner, and also to transfer £50,000 to a suspense account with a view to improvements which it may be desirable to make in the present provident fund arrangements. After payment of the above sums and of the annuity of £77,544 18s. to the National Debt Commissioners in respect of interest and repayment of the Capital of £2,000,000 advanced for the Pacific Cable, and of the annuity of £9,150 5s. to renewal fund for interest and sinking fund on £177,254 7s. 11d. borrowed for the Auckland-Sydney cable, the surplus is £9,580 13s. 1d., which will be applied in reduction of the outstanding balance of the £2,000,000.

The net traffic receipts exceeded those of 1917-18 by £152,537 4s. 10d., and were much higher than the receipts of any previous year, the increase being due to war conditions. The cable was fully loaded throughout the year, mostly with Government and full rate traffic. When the Board are in a position to reinstate the cheap classes of traffic the average revenue per word will be substantially lower. The expenditure (excluding special appropriations) exceeded that of the preceding year by £23,848 8s. 7d., mainly due to increased war allowances and overtime rates, and to the heavier calls upon the "Iris" for repair expeditions, resulting in her maintenance costs rising by £9,000.

The preliminary forecast of revenue and expenditure for the current year puts the traffic revenue at £350,000, the working expenses at £173,000 and renewal fund £39,150, showing an excess of £137,850. The proportionate revenue for the first five months of the year was considerably in excess of the estimate. There will be a substantial reduction of Government traffic in the early future, and it has already been found possible to reintroduce the deferred rate.

Working of Cables, &c.

The section of the cable between Norfolk Island and Southport became faulty on Aug. 19, 1918, and repaired by the "Iris" on Sept. 5, 1918. The breakdown did not have any serious effect upon traffic, as it was possible to circulate messages via Auckland and Sydney. During the repair operations the Norfolk Island Auckland cable was accidentally cut; an unsatisfactory section was cut out and the cable restored within a few hours. The other cables were maintained without interruption. The landline between Montreal and Bamfield worked well and suffered few serious interruptions. A further line, between Halifax (Nova Scotia) and Montreal has been leased from the Canadian Pacific Railway for 10 years. With this new line, the Board have direct connection with the Halifax end of the Imperial Atlantic cable, the English end being operated by the British Post Office.

The Board's auxiliary schooner "Tangaroa" maintained a satisfactory service between Honolulu and Fanning Isand for provisioning the station and for carrying staff on transfer and mails. Defects in the cold storage plant on the vessel have been remedied by the substitution of an engine of higher power for that originally provided with the plant. Owing to the heavy premium of £10 per cent. for wooden vessels employed in the Northern Pacific, the Board did not renew the insurance policies, but £18,000 from current revenue has been transferred to reserve fund to provide against any misadventure which might befall the vessel. The cable maintenance steamer "Iris" continues in first-class condition. The ship carried out two repairs to the Cook Straits cables on behalf of the New Zealand Post and Telegraph Department, and repaired one of the cables between Sydney and Wellington for the Eastern Extension Telegraph Company in October, 1918.

The Board again acknowledge the loyal and efficient service rendered by their staff. It has been possible to obtain a number of additional operators, and to arrange for the grant of furlough to officers whose leave is overdue. The Board regret to report that a number of their officers lost their lives through pneumonic influenza, and the station at Bamfield suffered severely, at one time only seven officers being able to take duty. In April, 1919, the Board increased the war allowance to the equivalent of 50 per cent. of salary, with retrospective effect from Oct. 1, 1918. With the exception of two officers who have not yet been demobilised, all the members of the head office staff who served with the Forces during the war have returned to their posts. The casualties were limited to one officer killed (Lieut. S. W. Collings) and one severely wounded.

Traffic.

During the year over 8,300,000 paying words of International traffic (*i.e.*, traffic other than local traffic in Australasia and the Pacific) were handled, or over 800,000 words in excess of the total for 1917-18, but 439,000 less than in 1916-17. Free messages to, from and in relation to wounded members of the Expeditionary Forces totalled 200,000 words, against 600,000. In addition to international traffic, 1,830,000 paying words were carried during the year between Australia and New Zealand, and between Australasia and the Pacific Islands, an increase of 100,000 words. Throughout the year the Board's system was congested with outward traffic, and at times the delay was very considerable. All other cable administrations were similarly situated. This congestion was due primarily to the larger amount of Government traffic, but it was seriously aggravated by frequent interruptions on the different cable systems and also by the absence of the alternative route for Eastern traffic formerly provided by the Indo European system. The signing of the Armistice in November, 1918, did not bring any relief; indeed, traffic actually increased. Telegrams relating to the conduct of hostilities, casualties, &c., were replaced by those relating to demobilisation. Government outward messages amounted to 72·85 per cent. of the total traffic from the United Kingdom. At the date of the report there were indications of a return to more normal conditions, and the average delay is now a few hours only. The establishment of the Imperial Atlantic cable, and the working by the Board of the landline from Halifax to Bamfield, completes a line of communication under Government control between London and Australasia. The measures necessary for strengthening this line and for increasing its capacity, if traffic conditions should require it, will have the careful consideration of the Board.

London Supply Companies' Staffs.

The annual general meeting of members of the Association of Officers and Staff Members of Electricity (Power and Supply) Companies of Great Britain will be held at Caxton Hall, Westminster, S.W., on Tuesday next, at 8 p.m., when the report of the Executive Committee and the accounts for the year ended Jan. 30 will be presented, and the election of officers, &c., will take place.

The report of the Executive Committee states that Sir Alex. B. W. Kennedy, F.R.S., has consented to accept the Presidency of the Association. Details are given of the steps taken by the Executive Committee to secure the necessary alterations in Clause 17 of the Electricity (Supply) Bill so as to safeguard the interests of members. In fact, the Committee claim that the substitution of the present satisfactory Clause 16 of the Electricity (Supply) Act, 1919, for the inadequate clause in the original Bill is mainly due to the efforts made by the association. The committee state that they endeavoured to secure the removal of the limitation of the operation of the clause to five years from the date of the coming into force of any of the schemes authorised by the Act, but without avail. They understand that it is the intention of the Government that all claims for detriment sustained in consequence of the Act shall be dealt with in that period, and that the interests of those officers and staff members of existing undertakings who may enter the service of the new authorities shall be safeguarded by pushing forward the schemes for superannuation authorised by section 8 (2) of the Act. It is said that the real work of the association only begins with the passing of the Electricity (Supply) Act. A further Bill has been announced, and in the future there may be other proposals affecting the industry by which the interests of members may be endangered. Attention is called to the importance of the proposed superannuation schemes.

The statement of accounts shows that the subscriptions amounted to £289 16s., and there is a credit balance of £183 5s. 1d. The principal items of expenditure during the year have been on account of printing, stationery, clerical assistance and postage, due to the large amount of propaganda, and to the work in connection with the Electricity (Supply) Bill. The committee recommend that the constitution as agreed at the general meeting in Jan., 1919, be amended. The Hon. Secretary of the association is Mr. O. M. Andrews, 19, Carnaby-street, Golden-square, W.1, and a good deal of the success already achieved is due to his efforts.

Copper Refining in Devon.

The syndicate responsible for the utilisation of the water power of the Dartmoor streams, which has been dropped for this year, proposes to erect a copper refinery near Newton Abbot. The chairman of the syndicate (Sir Gerard Muntz) presided over the Non-Ferrous Metal Trades Committee, and it will be remembered that the Committee strongly recommended that a large electrolytic refinery should be established in Great Britain, capable of producing 100,000 tons of copper a year for use in this country, as far as possible using British copper in blister form. There is at present no such refinery in the country, and 90 per cent. of the copper used comes from the United States. Close to the site chosen which has tide-water facilities, there is a bed of over 800 million tons of lignite, and it is proposed to use this in the generation of electricity. There will also be by-products plants. In addition to generating electricity for the copper refinery it is considered that power can be generated so cheaply that it will be possible to supply current in bulk to all the towns in South Devon, as well as to the industries which may be attracted to the neighbourhood.

We learn that the directors of the **Monaghan Lighting Company, Ltd.**, are putting down an electric lighting plant to supply electricity for lighting and power at a cost of about £8,000. The plant will include two 88 B.H.P. Crossley twin cylinder gas engines (town gas being used), two G.E.C. 50 kw. dynamos and motor booster, with a 725 ampere Pritchett & Gold E.P.S. storage battery of 125 cells. The capital of the company has been increased to £13,000, and an issue of 1,094 ordinary £5 shares has been over subscribed. The engineer, manager and secretary of the company is Mr. James Woods, whose enterprise and progressive ideas are to be commended.

Some New Electric Fittings.

With the large extension of electric lighting which is now taking place anything in the way of fittings to make its employment easier and more efficient is to be welcomed. We illustrate herewith an improvement which has been introduced by Lesco, Ltd. in the ordinary type of bayonet socket holder. At present a person who is trying to fix a shade ring has to perform an acrobatic feat with his fingers to do so. The designers of this holder, it is claimed, overcomes this trouble in the way shown in the illustrations (Figs. 1 to 3). The lampholder used is in two parts, the top being fixed to the bottom by means of a bayonet socket joint, and the two halves being held together by a locking ring. This locking ring also acts as a shade carrier in which function it is assisted by a small shoulder on the lower half of the body. The shade when in position rests on the shoulder and is held in position by means of the ring which is on the outside of the shade.

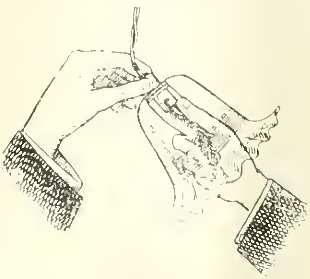
Fig. 1.—The Older Method of Fixing a Shade.

The interior of the holder consists of three parts. The porcelain carries the terminals and solid contacts and moves in a case against a spring. This spring takes the place of those behind the plungers in the ordinary holder, and its position is between the porcelain and cord grip. The cord grip consists of two moulded insulating parts, the top part having two holes drilled through it at an angle, and the bottom half having one hole drilled through its centre. One flexible is brought through each of the holes in the top half, then through both the holes in the bottom half. As shown in the illustration this puts a slight kink in the leads which enables them to withstand a direct pull of about 60 lbs. Fig. 3 illustrates the ease which the shade can be fitted when a Lesco holder is used. Our one criticism is that the means employed for supporting the shade seems frail for the weight that may have to be supported.

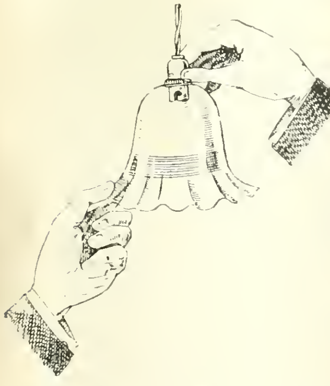
Fig 2.—The New Method.

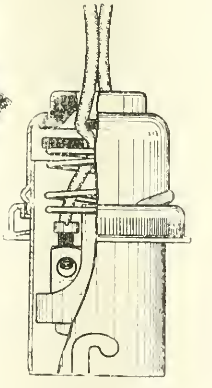
Fig. 3.—The Lesco Holder showing Spring and Cord Grip.

An interesting series of fittings have been put on the market by the Easy Fix Fittings Company. At the present time tumbler switches and ceiling roses are fixed by screwing them direct to the box or the cover of a conduit, a system which sometimes gives rise to difficulties owing to lack of registration between the holes in the porcelain and those in the cover. To alter this means waste of time and often broken porcelains. With "easy fix" fittings it claimed that these difficulties are overcome by the use of small undercut flanges on the rivetted box which engage in specially constructed slots on the wings or flanges of the ceiling rose. The fitting is made secure by simply screwing home the switch or ceiling rose and when in position is gripped at three points and locked to the heavy screw thread in the cover.

An adjustable fitting which has been specially designed for use in works is that made by Purrett Specialities, Ltd., and is shown in the accompanying illustration. (Fig. 4.) This fitting allows every part of the work in a machine to be adequately illuminated from any angle as the operator requires.

Our particular illustration shows a two-arm fitting, but one arm or three arm patterns are also made. These arms which are pressed to a special form from a steel plate are connected to each other and to the base and lamp shade holder by standard bolts, spring washers and nuts. It is claimed that while allowing perfect freedom of movement they will stand in their set position under all conditions of vibration of machine tools. The bottom end of each arm is secured to a swivel joint carried on a base bracket and the top end of the arm has also a jointed swivel connection in which the lamp shade is secured so that a universal movement is obtained at the lighting point. The reflector illustrated is of vitreous enamelled both inside and outside, and is so arranged as to completely to protect the lamp from risk of breakage. The wiring of this fitting is shown in the illustration. It is claimed that this prevents all damage to the cable.

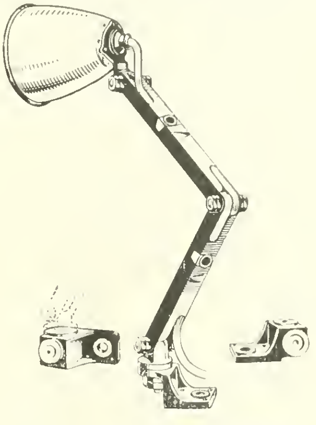
Fig. 4.—New Adjustable Fitting.

Electrical Wholesalers' Federation.

The annual general meeting of this Federation was held on Wednesday last at the Hotel Russell, London, and the luncheon, to which the Press were invited, was presided over by Mr. Walter Donovan, the chairman of the Federation. About 45 members were present out of a total of 53, the membership of the Federation to date. After the loyal toast, the chairman gave that of the "E. W. F." and remarked upon its development since 1914, when it could only boast 12 members. The Federation had framed a definite interpretation of the term "factor," and this strict ruling had compelled the Committee during the past year to excuse themselves electing as members of the E.W.F. a number of firms who could not accurately qualify. The Federation had proved that its services were both a necessity and a convenience to the industry. Manufacturers were recognising that the factor could function in his correct capacity as a distributor, that he could give honest service, and that those services justified preferential terms. He believed that the future of the factor was a bright one, and that fact gave great promise for the business of electrical distributing throughout the British Empire. In a recent article in "The Times" the future of the electrical industry was considered, and that included complimentary reference to the work of the E. W. F.

The toast was enthusiastically honoured, and the chairman then, on behalf of the Federation, presented a substantial cheque to the hon. secretary, Mr. A. G. Beaver (Sun Electrical Company) for the purchase by himself of some token which would mark the esteem and regard of the members for his untiring services. Mr. Beaver, who was greatly moved by the present, replied, and stated that his work in assisting the development of the Federation had been of a most pleasurable kind, and he would continue to help the organising of the electrical distributing business. He subsequently gave the toast of "The Press," to which Mr. S. R. Rentell suitably replied.

B.T.H. Thermostatic Metal.

The action of this metal, which has been developed for use on thermostatically operated devices, may be summed up by saying that it bends with the heat. The uses to which the metal may be applied are many and various. It is employed for temperature indication, temperature control or temperature compensation in oven thermometers, electric heaters, ice machines, refrigerators, thermostats, scientific instruments, motor ignition, battery charging, electric signals, carburetters, computing scales, &c.

This metal is in the form of a duplex strip, prepared by the permanent union, throughout their entire length, of two metals with widely differing coefficients of expansion. When the strip is subjected to a change of temperature the difference in the rates of expansion or contraction of the two halves causes the whole strip to bend one way or another. This reaction is always the same for a given length and thickness of strip and a given temperature change, and consequently provides a reliable basis for the operation of any thermostatic device. The union between the component metals is complete and durable. No matter how much the strip is bent, twisted or hammered, the metals will not separate at any point, and even with heating the bond will not be broken down at a temperature below the melting point of the softer of the two metals. Owing to this permanency of union the metal can be formed into any desired shape and annealed after formation. It can be safely employed at any temperature below 500 F. The component metals will not corrode under ordinary conditions, and may be used in any reasonable situation without fear of deterioration or change in operating characteristics. Briefly stated, the laws governing the deflection of the metal are as follows:

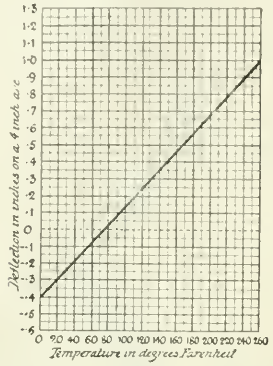

Fig. 1.

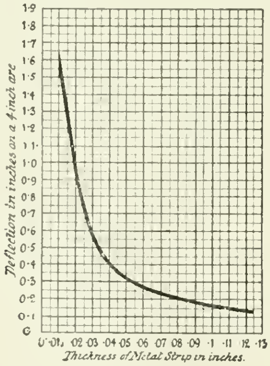

Fig. 2.

Deflection due to temperature change varies: inversely as the thickness, as the square of the length, is not affected by changes of width and it varies directly with degrees temperature change. Force exerted upon temperature change varies: as the square of the thickness, is not affected by changes in length, varies directly as the width, and as the square of the degrees temperature change. Force required for permanent set varies: as the square of the thickness (between narrow limits), inversely as the length and directly as the width. Fig. 1 shows the deflection obtained from a metal strip (4 in. long, 5/16 in. wide and 0·03 in. thick), subjected to different temperatures, and Fig. 2 the deflection from different thicknesses of a strip subjected to a temperature change of 100 F.

Thermostatic metal is made in standard thicknesses ranging from 0·015 in. to 0·25 in. in widths up to 6 in., and lengths to suit the purchaser, and in special cases thermostatic metal parts may be completely formed to specification. Further information regarding B.T.H. Thermostatic Metal is given in descriptive list No. 10,952, which may be obtained on request from the British Thomson-Houston Company, who own the British rights under Patent No. 113,758.

Annual Dinner of North-Western Centre of the Institution of Electrical Engineers.

The annual dinner of the North-Western Centre of the Institution of Electrical Engineers took place on Friday last at the Grand Hotel, Manchester, Mr. J. A. Robertson being in the chair.

Mr. E. F. Stockton, president of the Manchester Chamber of Commerce, proposed "The Corporations of Manchester and Salford," which was replied to by the Lord Mayor of Manchester (Alderman Fox) and Councillor G. Billington, chairman of the Salford Electricity Committee. All three speakers mentioned the amalgamation of the two areas, the Lord Mayor suggesting that electricity could be supplied more economically from one centre with a very large output, while Councillor Billington expressed doubt whether Manchester could produce electricity cheaper than Salford. He thought, however, some scheme of federation or amalgamation would come.

The Chairman, on behalf of the members of the Centre, presented Mr. Julius Frith with a 4 in. Drummond lathe and a silver tray (for Mrs. Frith) in recognition of his services as honorary secretary during the last seven years. In responding, Mr. Frith remarked that there had been many stirring events in the seven years, and he hoped to see further developments of the scientific side of Manchester life. In particular he advocated the establishment of a library, which would enable busy men to keep in touch with the technical press throughout the world. Much time would be saved if a staff of readers were employed to sift the material and draw the attention of engineers to methods that they were especially interested in.

Mr. J. Phillips Bedson proposed "The Institution of Electrical Engineers." In replying, Mr. Roger T. Smith, president of the Institution, congratulated the Centre upon the spirit of self-sacrifice it had shown in doing all that was possible to assist the formation of the subcentres at Liverpool and Preston. Decentralisation had been going on for many years, and Manchester had taken a very important part. No one had done more to bring home the importance of decentralisation and make the Institution feel that it had got a new life and a new interest than Mr. Wordingham. But the traditions of the Institution were centred in London. They must always be centred in the capital of the Empire, of which they were all citizens. Those traditions were an inheritance which ought to be cherished very carefully. By all means discard what was obsolete and bad, but no change should be made simply for the sake of change. As the President, he urged the members to help the Council in looking after that inheritance, and to endeavour to leave the Institution better than they found it.

Mr. C. H. Wordingham, in proposing "The North-Western Territorial Centre," said the Institution would benefit from the establishment of the subcentres at Liverpool and Preston, and along with it that Centre also. He suggested that, as the chairman and past chairmen of a centre were members of the Council, so in a similar way the chairman and past chairmen of a sub-centre should be members of the Committee of the Centre. He joined with the president in urging the essential need for the Council to be fully supported by every Centre.

The Chairman, in reply, said the Centres were absolutely loyal to headquarters, but they did not always see eye to eye with it, and they had not always been dealt with as considerately as they thought their position entitled them to be. London was the head, but the provinces supplied the force and energy which made the Institution live. In Manchester they had a very strong students' section, which ought to receive larger recognition. Some of the Papers contributed by students should not be allowed to fall into oblivion, and he was going to suggest the publication of a students' journal. For a number of years the Institution had had a lady member, and quite recently another lady, who came from the North-Western Centre, had been admitted to the associate membership. He also drew attention to the case of those men whose training was interrupted by the war. The door of the Institution must be closed so far that no unqualified men could get in; but, at the same time, he thought the door might be opened just a little wider for these men. The Membership Committee in London must take the local centres more into its confidence with regard to applications for membership.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Practical Electric Welding." By H. Bevan Swift, A.M.I.E.E. (London: E. & F. N. Spon.) Pp. 104.

"Mathematics for Engineers." Part II. By W. N. Rose, B.Sc. (London: Chapman & Hall.) Pp. xiv.+419. 13s. 6d. net.

"The Financier Rubber Share Handbook." (London: The Financier.) Pp. xii.+938. 6s. 6d.

Commercial Topics.

Importance of Definite Contracts for Foreign Goods.

The Overseas Trade Committee of the Federation of British Industries has been devoting attention to the important question of "definite contracts" for goods destined for the Chinese and other foreign markets. It appears that the British Chamber of Commerce in Shanghai recently reported that British manufacturers were inserting, or endeavouring to insert a clause in contracts, reserving the right to advance prices should cost be increased through war, riot, civil commotion, advance in prices of materials or wages, or through any other cause whatsoever. The manufacturers also desired to make the clause applicable to contracts accepted at fixed prices during recent months. There is a fear that the present unprecedented practice must seriously affect British prestige and jeopardise British markets in the Far East. It is stated that American manufacturers were not insisting on any such clause, with the result that many large contracts were being placed in the United States.

We are glad to learn that the Committee of the Federation came to the unanimous conclusion that the matter should be brought to the notice of members in its "Bulletin" and that special attention should be directed to the question. One of the greatest assets of British firms in the past in their relations with the Chinese has been their steady adherence to contract terms. This principle is especially important in regard to dealings with China for, to the Chinese, whose own word is as good as their bond, the name of Great Britain has always represented their conception of the highest standard of commercial integrity, and they are unable to understand a contract which is neither binding nor definite.

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Income Tax on Municipal Undertakings.

A question of considerable importance to municipal electric supply and tramway undertakings has been under consideration by the Finance Committee of the York Corporation. The Committee was asked by Mountain Ash Urban Council to support the principle that local authorities should be assessed for income-tax in precisely the same position as a private individual, so that where the local authority owns two or more trading undertakings they should be entitled to set off against the profits of any one or more of those undertakings the losses incurred in any other undertakings, and thus be only liable to income-tax on the net result. In the course of the discussion it was alleged York Corporation Council was charging a larger amount than need be for electricity that the charges were so high that the Corporation was paying £1,000 more than before the war in income-tax. The Electricity Committee was bound to place money aside for a sinking fund and they had to pay income-tax on that. It was agreed to support the Mountain Ash resolution, but Ald. Meyer, chairman of the Electricity Committee, stated the charges for electricity in the city were quite moderate and compared favourably with those in other towns of the same size.

The incidence of the income-tax has been frequently debated by Electricity and Tramways Committees, but little progress has been made with the demand for the separate assessment of each municipal trading department. In view, however, of the early publication of the report of the Royal Commission on Income Tax the present is a favourable time for some concerted action to be taken.

* * * *

Publication of Official Trade Reports.

The Overseas Trade Department is preparing for publication handbooks of commercial information relating to various countries. These publications, which are intended to be books of reference for British traders, will give particulars of the resources, products, commercial treaties and law, transport, trading methods, &c. The manuals for France and the Argentine are nearly ready, and some material has been accumulated for those on Brazil, Italy and Greece.

The department also proposes to issue periodic reports sent in by commercial diplomatic officers. These are intended to take the place of the old Consular reports which were issued periodically from 1858 until the war. It is to be hoped that these reports will be more up-to-date and more helpful to traders and exporters than the old publications. So far as the electrical industry was concerned they were of little use; electric supply traction and undertakings were seldom noticed, and when an engineering project was referred to the information was usually very meagre and belated.

It is now stated that when the organisation of the Economic and Editorial Section is complete it will also be possible to prepare special economic memoranda on topics of outstanding interest which are not otherwise provided, either because of the technical research involved or because of their broad international character. At present the section is dealing with reports upon the economic and trade situation in countries severely affected by the war. Sir Hubert Ll. Smith called for special reviews of this character, and these are now being brought together so as to form a general survey of European trade conditions at the close of 1919.

No doubt the proposed handbooks and reports if properly prepared and edited will be useful. The information given should be strictly accurate and reliable; but as the matters covered by the publications are liable to frequent changes we hope that arrangements will be made for their revision from time to time. From long experience of Government publications we think that this will not be done without the aid of an advisory committee of the commercial and trading interests.

Electricity Supply.

Derby Corporation has applied for sanction to a loan of £[illegible] for meters and transformers.

Kingussie Corporation has instructed the Burgh Surveyor to prepare a report on the cost of public electric lighting.

The salary of the Burton on Trent electrical engineer and manager, Mr. T. Hall, has been increased to £650 per annum.

Cannock Urban Council has engaged Mr. A. Ellis at a fee of 100 guineas to prepare a report on the supply of electricity to the area.

The Board of Trade has revoked the Knottingley Electric Lighting Order, 1914, as to the whole area of supply, as from Jan. 9, 1920.

Birmingham Education Committee recommend an expenditure of £2,335 on electric light plant at the Sanstok Industrial School.

Chester Corporation has called a conference of local authorities in Cheshire and Flintshire, to be held at Chester for the purpose of considering the formation of a joint electricity authority.

Clacton Urban Council has been authorised to borrow £5,500 for the extension of the supply mains and for converting the street lighting system from gas to electricity.

Nelson Council has authorised the acceptance of tenders amounting to £82,869 for extensions of the generating plant at the electricity works, which will suffice for 12 or 18 months.

The general principle of electric lighting and gas cooking and heating has been adopted by Oldham Corporation Housing Committee with regard to their new scheme of municipal housing.

Shoreditch (London) Borough Council has been authorised to borrow £3,735 for mains (repayable within 25 years), £12,500 for converters, &c. (15 years) and £1,684 for house services (12 years).

The proposed site for an electricity generating station at Portrush has been approved, and the Urban Council has referred the question to the Lighting Committee and consulting engineer.

The grain warehouses of the Mersey Docks and Harbour Board at Birkenhead are to be modernized, and electric elevators and conveyers are to be installed at an estimated cost of about £35,000.

The housing schemes of Sheffield Corporation are making slow progress, but provision is being made for the supply of electricity to the estates, and the streets of the Brushes Estates are to be lighted electrically.

Battersea (London) Borough Council has received sanction from the London County Council to borrow £74,354 for a 5,000 kw. turbo-alternator and a 1,500 kw. rotary convertor, the loan being for 15 years.

Swansea Electricity Committee has decided that it is not possible to allow a 48 hour week to the shift engineers. The Committee has acquired an option to purchase Messrs. Player's generating plant at Clydach.

Dewsbury Council has made application for sanction to borrow £8,500 for the purchase of converting plant in connection with the scheme for a supply of electricity in bulk from the Yorkshire Electric Power Company, and also £13,620 for feeder and cable extensions.

A long report by the city electrical engineer (Major H. Bell) on the electricity undertaking has been considered and adopted by Hull Electricity Committee. Additional plant, including four boilers and transformers will be ordered. A new 10,000 kw. turbine set is being put down and this will probably suffice to meet the demands for three years.

The Swansea Electricity Committee announce that the Institution of Electrical Engineers will visit Wales in July. It is proposed to make Cardiff a centre, with visits to Bristol, Hereford and Swansea. The Committee agreed to give a hearty welcome to the visitors and the Mayor will entertain them.

Blackburn Electricity Committee has conditionally accepted applications from the Rishton and Great Harwood Urban Councils for supplies of electricity, and also a request for a temporary supply to Preston on the completion of the new generating station. Application has been made for sanction to a loan of £130,000.

Rochdale Electricity Committee is negotiating for a further supply of electricity in bulk from the Lancashire Electric Power Company; but a question has arisen on certain clauses of the Electricity (Supply) Act affecting power companies, and, owing to the difficulties of obtaining generating plant, the negotiations have not yet been completed.

The Board of Trade has extended for six months from the 31st ult. the periods limited by the Kingston-upon-Hull Electric Lighting (Extension) Order, 1914, for laying mains, &c., in specified streets and in the remainder of the area. The Board has also made a similar Order in the case of the Rickmansworth and Chorley Order, 1914.

Ald. Grimshaw informed Wigan Corporation last week that whilst the loss on the electricity department for nine months a year ago was £500, the profit this year was £8,000, and would be £12,000 at the end of the present year. It would be necessary to build a new generating station to meet the big demand for electrical energy, and the scheme would probably represent an expenditure of nearly half-a-million pounds.

There is a rapidly increasing demand on St. Annes-on-Sea electricity works. In December 27 new consumers were connected, and in January 31 were added. If the present rate of increase is maintained the plant capacity will be reached by 1921. The electrical engineer (Mr. Clother) proposes to lay a new feeder of 1,700 yards at a cost of £5,074. The Council have applied for a loan of £10,074, including £5,000 for mains.

In submitting the estimates of the electric lighting Committee to Edinburgh Corporation last week the convener (Mr Bruce Lindsay) explained that it had been proposed to put down two additional boilers at Dewar-place station, and a 2,500 kw. turbo-alternator at McDonald road at a cost of £13,000; alterations on one of the structures at Dewar-place would cost £800; and additional feeder cables in the outlying districts, £14,000. However, it was now proposed to put the Sheffield boilers in a temporary building at Dewar-place, and to instal the new boilers at McDonald road, thus avoiding structural alterations. It was also proposed that instead of buying a second-hand turbo-alternator at £20,000 they should purchase a new 4,[illegible] kw. set from Messrs. Parsons & Company, at £32,000. The proposed change would effect a great saving. They would have ample electrical power for all purposes, and they would be ready to supply energy for the Pilrig-Liberton tramways when required.

The report was recommitted with power to act.

West Ham Corporation has received sanction to borrow £140,317 for the electricity undertaking, viz., £22,000 for 25 years, £62,450 for 17, and £55,867 for 15 years. The Finance Committee, reporting on ways and means of providing the money, states that as the periods of the sanctions were from 15 to 25 years, it would be possible to utilise the loans fund sinking funds as follows:—At once, £22,000; April 1, 1920, £8,900; October 1, 1920, £53,000; January 1, 1921, £42,000, subsequently, £14,417. This would necessitate a considerable amount of book entries, transferring practically all the individual balances, accumulating in the numerous sinking funds during the next 15 months. These transfers will exhaust the available balances in the sinking funds, and no further money can be obtained from this source for capital purposes before 1922. The Council has adopted the suggestion and £22,000 is to be withdrawn from the loans fund and placed to the capital account, interest being reckoned at 5¾ per cent. per annum.

Stepney (London) Borough Council has authorised the installation at the Osborn-street sub-station of two 1,500 kw. converters, at an estimated cost of £20,000, and of switchgear, galleries, &c., at £6,000. The borough electrical engineer and manager (Mr. W. C. P. Tapper), having reported that the recent breakdown in the supply was due to the exceptionally low spring tide coinciding with a westerly gale, the effect of which was to cut off the supply of river water from the suction boxes, the Electricity Supply Committee recommended that steps be taken for the provision of wharf, jetty, river pipes and wells at the Limehouse generating station at a cost of £36,300. This work is part of the big scheme of extensions at the Limehouse station which was prepared by Mr. Tapper in October last, and is estimated to cost £534,700.

The recommendation was approved by the Council on Monday, as was another proposal to install a 10,000 kw. turbo-alternator (instead of a 5,000 kw. to 8,000 kw. set at Limehouse, and the additional expenditure entailed (£7,000) was sanctioned. Application is to be made for sanction to borrow £71,900 for the above-mentioned plant and works.

Electric Traction.

Dublin Corporation has instructed the Town Clerk and the Law Agent to report as to the necessary steps to be taken to secure the municipalisation of the tramway system of the Dublin United Tramways Company.

Sheffield Corporation has decided to fit 50 open-ended tramcars with vestibule ends, at a cost of £240 per car. In future, charges are to be made for articles and property left by passengers in the tramcars and motor omnibuses of the Corporation.

Something like £160,000 will, it is estimated, be necessary to provide the additional tramcars, extend the car sheds, and carry out other work on the Manchester Corporation tramways undertaking during the financial year, 1920-21, and the Tramways Committee propose until borrowing powers are obtained, to meet expenditure out of revenue.

The London County Council propose to allow blind persons to travel free on their tramcars. At Tuesday's meeting formal approval was given to the decision to apply to Parliament during the present Session for powers to extend the tramways, to own omnibuses and to run auxiliary omnibus services for linking up tramway dead ends, &c. The Council will oppose the London, Electric Metropolitan, District, City & South London and Central London Railway Companies (Fares, &c.) Bill, so as to secure that only such fares are authorised and charged as are reasonably necessary.

An important announcement was made as to the electrification of the Suburban lines of the G. E. Railway Company at the annual meeting of the shareholders last week. The Right Hon. Sir Ailwyn E. Fellowes, K.C.V.O., K.B.E. who presided, stated that with a view to meeting the increasing demand made upon their railways in consequence of the growing traffic which had to be handled, and also to assist in the further development of the system, the board had instruteed the general manager, acting in consultation with other experts, to prepare a scheme of electrification. Sir Henry Thornton was devoting much time and attention to the subject, which necessarily claimed thorough and exhaustive investigation. In Sir Henry Thornton's opinion the suburban zone served by the railway lent itself more readily to electrification than that which existed in most other suburban areas, because they had a great density of traffic, a number of diverging traffic routes, centring in one terminal, and an immediate and pressing demand for increased passenger facilities. The investigation had not proceeded far enough to permit predictions as to the financial results, but it might be said that material economies, coupled with a large stimulation of travel, were not beyond the bounds of possibility.

Imperial and Foreign Notes.

The accounts of the electric lighting department of Wellington (N.Z.) for the year ended March 31, 1919, show revenue £94,418 (compared with £87,536 in previous year), working expenses £47,840 (£41,624), interest and sinking fund contribution £10,311 (£10,327), and contributions to renewals and reserve and special appropriations amounted to £16,383 (£17,805), leaving net profit £19,984 (£17,780). Units generated were 7,009,110 (6,599,135) and sold 5,455,248 (4,956,388). Motors connected aggregate 1,539 h.p. (1,559 h.p.). The tramways revenue was £222,892 (£218,320), working expenses were £167,684 (£155,886), and after providing for interest, sinking fund, renewal and reserve funds, and special appropriations, the net credit balance was £614 (£11,60[illegible]). Passengers carried were 33,965,692 (33,156,953) and car-miles run 2,953,494 (2,977,617). Power supply (which is also dealt with by the tramways department) produced a revenue of £22,462 (£19,129), and a net surplus £2,233 (£947). Units sold were 2,057,443 (1,804,479), and motors connected amounted to 5,687 h.p. (5,411 h.p.).

A complete all-electric steel mill is being erected by the Electric Alloy Company at Youngstown, Ohio. Two large electric smelters and two rolling mills will provide for the manufacture of vanadium, chrome and nickel steel.

The Siemens & Halske Company made a gross profit for the past year of M.15,736,122 (including amount brought forward), compared with M.17,750,818 in the previous year. The net profit was M.11,457,441, against M.13,954,780, out of which a dividend of 12 per cent. is again paid.

According to "L'Electricite," the question of electrifying about 6,000 km. of railway in Italy is under consideration. This will include both State owned and privately owned lines, and the sum of 800 million lire has been issued for the purpose. The work will be carried out under the supervision of the State Railways Administration, and the necessary electric rolling stock will also be provided by them. Energy required for operating these railways will, in general, be taken from the privately owned enterprises, except in special cases where this is not available, when the State will make its own arrangements. The scheme primarily includes the electrification of the main lines of certain sections in the Apennines, and of the principal main branch lines in that area bounded by Milan and Reggio and Turin and Trieste. It is suggested that in the Apennines a series of steam operated stations would be erected and would utilise lignite or peat as fuel. It is hoped in this way to conserve the coal supply. It is calculated that the water-power available in the Trentino is about 500,000 h.p. This is to be found in the basins of the Adige, the Upper Adige, the Alpine lakes, and of the Sarca, Chiesse and Brente.

Obituary.

We regret to record the death of Mr. G. H. Moreton, who was for many years manager of the Plymouth, Stonehouse & Devonport tramways. Deceased had reached the ripe old age of 82 and witnessed the passing of the old horse omnibus and its substitution by horse-drawn tramcars and the subsequent introduction of electric traction.

The death recently took place of Mr. Charles E. Groves, F.R.S., F.C.S., F.I.C., who was for some years editor of the "Journal" of the Chemical Society. He was also one of the founders of the Institute of Chemistry and its first secretary. At one time Mr. Groves was lecturer in chemistry at Guy's Hospital and consulting chemist to the Conservators of the River Thames.

By the death of Albert Schmid, which occurred in New York on Dec. 31 last, the engineering world has suffered a serious loss. Mr. Schmid was not only closely identified with the early development of the electrical machinery in the United States, but was also prominent in the electrical world of France, Switzerland, Italy and Great Britain. He was born in Zurich in 1857 and began his engineering career with the French Westinghouse Air Brake Company. Being invited to America by the late Mr. Geo. Westinghouse in the early 80's he turned his attention to designing work for the Westinghouse Air Brake Company. When Mr. Westinghouse became interested in the Union Switch and Signal Company and started his original electrical work he engaged Mr. Schmid as his chief designer and engineer in that field. In 1886 he was transferred to the newly created Westinghouse Electric Company, becoming its first chief engineer, and in 1896 its General Superintendent. In 1897 he went to Europe to study the Continental electrical developments and, as a result of the trip, the French Westinghouse Company was formed. He was made Director General of that organisation, and he also held the positions of Director of the Westinghouse Electric Company, Ltd. of England, President of the Campagnie des Lampes a Filament Metallique of France, and at the time of his death, in addition to his position as consulting engineer for the American Westinghouse Company, he represented the Westinghouse Lamp Company and had general supervision of its interests abroad. As chief engineer of the Westinghouse Electric Company prior to 1896, he was directly concerned with the development of many forms of electrical apparatus, including the modern industrial motor, the electric railway motor and the transformer. He took out many patents, and two of his early patents are of especial interest to electrical men; his first (in 1889) covers "a film of oxide to insulate from each other the steel laminations," used in armatures, transformers and other electrical apparatus—the method that now, and probably always will be in universal use for such purposes. The second patent, issued in 1892, covers a design for an electrical machine, which became the typical Westinghouse structure.

Miscellaneous.

"Aeronautics" announces that the dinner of the FIRST 100 AVIATORS and pioneers of aviation has been unavoidably postponed. Full particulars of the new date fixed will be announced in due course.

The members of the engineering trade unions (about 600,000) are to take a ballot on the question of PAYMENT by RESULTS. At the recent conferences at York between engineering employers and workers it was impossible to arrive at an agreement on the question.

A Radio Research Board has been formed by the Department of Scientific and Industrial Research to co-ordinate and develop RESEARCHES in WIRELESS TELEGRAPHY and TELEPHONY at present being undertaken by Government Departments. The members of the Board are:—

Admiral Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S. (chairman), Commander J. S. Salmond, R.N., Lieut.-Colonel A. G. T. Cusins, C.M.G., Wing-Commander A. D. Warrington Morris, C.M.G. O.B.E., Mr. E. H. Shaughnessy, O.B.E., and Prof. J. E. Petavel, F.R.S., representing the Admiralty, War Office, Air Ministry, Post Office, and Department of Scientific and Industrial Research respectively) and Prof. Sir Ernest Rutherford, F.R.S.

The proper recipe for a Bohemian concert is said to be a company composed (in approximately equal proportions) of both sexes, dissolved in a suitable mixture of mirth, music and refreshment. Anyway, these were the constituents of the Mazda Bohemian Concert held on the 6th inst. at the Falstaff Hotel, Eastcheap. An excellent programme of music was brilliantly carried out by the various artistes, most of whom were members of the Mazda House staff. The function, the first of its kind since the war, was in a true sense a reunion, as the energetic organisers, captained by Mr. W. E. Bush, had gathered into this temporary fold many former members of the staff. The chair was occupied by Mr. E. Coote who, at the unanimous request of the audience, caused a message of sympathy to be sent to Mrs. Willcox, accompanied by earnest wishes for the speedy recovery of Mr. F. W. Willcox, the General Manager of Mazda House, who has been seriously ill for some weeks.

At the request of the Works and Staff Committees of the Metropolitan-Vickers Electrical Company, Ltd., at the Manchester works, an interesting course of 10 lectures has been arranged by the education department of the company. A special effort has been made to introduce lectures of a non-technical character and such as should appeal to the widening outlook of all grades of industrial workers. Four of the lectures, which are delivered on Thursdays in the "A" Punch Canteen (commencing at 5.15 p.m.), and are normally of 40 minutes duration, have been delivered. The lectures have been well attended, and are followed by a short discussion. Future lectures will be on "Education and Industry," by Mr. H. J. Brocklehurst; "Pattern making, with Special Reference to Plate Moulding," by Mr. R. W. Kemlo; "The Steam Turbine," by Mr. P. L. Jones; "The Legitimate Sphere of Trade Unionism," by Mr. F. Kirkley; "The English Banking System," by Mr. R. Dobson; and "The Economics of Industry," by Prof. C. R. Fay.

An INQUEST was held at Redcar on the 4th inst. on Samuel G. Mackenzie, cabin boy and electric pump attendant, of Middlesbrough, who was recently killed at the Warrendby Ironworks. The lad was found lying on a live wire, and Elisha Price, electrician, stated that he did some repairs to the apparatus driving the electric pump, and, as far as he was aware, everything was covered up in the proper manner when he left. He did not know there was an earth wire attached to the switch box. It was part of his duty to see that such wires were connected, but these were generally fitted when the plant was installed, and he took it for granted it would be so in that case. William R. Davidson, chief electrician, said he found after the accident that the switch was not earthed. The apparatus had been worked from another switch, and the one connected by Price was not intended to be used. A verdict of "Accidental death" was returned. The Coroner said there was evidence of a certain amount of neglect on the part of Price, who ought to have made a closer inspection of the apparatus, and also on the part of the foreman who ought to have earthed the switch when the apparatus was installed.

In its January "Journal," the Electric Trades Union states that its pre-war membership of about 10,000 has grown to nearly 50,000 at present. In the engineering and shipyard sections wages have increased by about 100 per cent. during the war. It is stated that, "unfortunately, the moulders' strike has placed us in an unfavourable position for further negotiation at the moment, but as soon as the position again becomes normal a determined effort is necessary to raise the standard of life." In the electrical contracting section advances have been secured under agreements made through the National Joint Industrial Council; but there are differences of opinion in the union on the merits of this body, although the agreement of December, 1919, "has placed the workers in this section in a more favourable position than the engineering or shipbuilding sections." Great progress has been made in the section organising workers employed in the generation and distribution of electricity. Separate negotiations have been proceeding with the railway companies for standard conditions throughout all the companies. It is also stated that the E.T.U. is actively organising kinema operators, and has come to an agreement for joint working with the National Association of Theatrical Employees. Other sections in which important new agreements have been reached include sea-going electricians, electricians in the printing trades, on tramway systems and in steel works. The most vexed questions at present is that of the relations between the E.T.U. and the Electrical Power Engineers' Association. There is a similar dispute between the F.T.U. and the Association of Supervising Electricians.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during December, 1919, and (*b*) the aggregate figures from Jan. 1 to Dec. 31, with increase or decrease compared with corresponding periods of 1918

Electrical machinery, (*a*) £189,165 (increase £162,871), (*b*) £861,623 (increase £241,597); including generators and motors other than for aeroplanes, motor cars and cycles, (*a*) £61,380 (increase £42,824), (*b*) £339,553 (increase £163,816 electrical machinery unenumerated (*a*) £127,785 (increase £120,047), (*b*) £522,970 (increase £77,281); telegraph and telephone cables, submarine, (*a*) nil, (*b*) £38 (increase £38); other than submarine, (*a*) £447 (decrease £9,792); (*b*) £12,209 (increase £2,963); telegraph and telephone apparatus, (*a*) £68,072 (increase £62,984), (*b*) £306,962 (increase £259,353); other electrical wires and cables, rubber insulated, (*a*) £356 (increase £356), (*b*) £7,830 (increase £5,610); with other insulations, (*a*) £5,282 (increase £5,282), (*b*) £20,946 (increase £14,940); carbons, (*a*) £3,453 (increase £377), (*b*) £29,686 (decrease £3,798); glow lamps, (*a*) £98 (decrease £5,879), (*b*) £213,771 (increase £18,033); arc lamps and electric searchlights, (*a*) £172 (increase £172), (*b*) £203 (increase £203); parts of arc lamps and searchlights (other than carbons), (*a*) £4,576 (increase £1,955), (*b*) £71,979 (decrease £26,872); primary and secondary batteries, (*a*) £5,084 (decrease £6,403), (*b*) £46,314 (decrease £95,446); meters and measuring instruments, (*a*) £3,744 (decrease £4,382), (*b*) £40,26[illegible] (increase £8,510); switchboards, (*a*) £90 (decrease £4,910), (*b*) £1,356 (decrease £6,554); electrical goods and apparatus unenumerated, (*a*) £59,848 (increase £36,127), (*b*) £453,607 (decrease £29,287). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £141,822 increase £82,700), (*b*) £1,205,161 (increase £156,093).

Exports.—The exports of electrical machinery, material, &c., (*a*) during December, 1919, and (*b*) from Jan. 1 to Dec. 31, with increase or decrease compared with corresponding periods of 1918, were as follows:

Electrical machinery, (*a*) £292,994 (increase £140,003), (*b*) £1,821,566 (increase £292,156); including railway and tramway motors, (*a*) £6,355 (increase £5,685), (*b*) £91,679 (increase £53,254); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £126,387 (increase £91,112), (*b*) £1,059,987 (increase £438,977); and electrical machinery unenumerated, (*a*) £202,994 (increase £140,003), (*b*) £1,821,566 (increase £792,156); telegraph and telephone cables, submarine, (*a*) £78,070 (decrease £28,420), (*b*) £622,452 (increase £44,454); other than submarine, (*a*) £57,505 (increase £38,764), (*b*) £520,935 (decrease £42,278); etlegraph and telephone apparatus, (*a*) £48,747 (increase £36,727), (*b*) £420,450 (increase £224,264); other electrical wires and cables, rubber insulated, (*a*) £97,487 (increase £76,512), (*b*) £828,058 (increase £737,970); with other insulation, (*a*) £137,967 (increase £132,923), (*b*) £1,078,602 (increase £979,071); carbons, (*a*) £996 (increase £358), (*b*) £13,194 (increase £5,016); glow lamps, (*a*) £10,557 (increase £6,385), (*b*) £150,357 (increase £73,923); arc lamps and searchlights, (*a*) £27 (decrease £33), (*b*) £7,506 (decrease £9,669); parts of arc lamps and searchlights (other than carbons), (*a*) £776 (decrease £537), (*b*) £10,670 (increase £4,687); primary and secondary batteries, (*a*) £28,052 (increase £15,950), (*b*) £435,357 (increase £312,764); meters and measuring instruments, (*a*) £22,211 (increase £9,845), (*b*) £239,794 (increase £109,621); transformers, (*a*) £12,314 (increase £3,316), (*b*) £104,348 (increase £65,022); switchboards, (*a*) £5,728 (increase £4,918), (*b*) £49,280 (increase £14,534); electrical goods and apparatus unenumerated, (*a*) £144,718 (increase £105,058), (*b*) £1,332,432 (increase £914,607). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £646,155 (increase £401,776), (*b*) £5,813,437 (increase £3,424,612)

Personal and Appointments.

A contemporary announces that in addition to Sir John Snell, Mr. Harry Booth, of the Ministry of Transport, and Mr. A. Page, general manager of the Clyde Valley Electrical Power Company, have been appointed Electricity Commissioners. We have, however, been unable to obtain any official confirmation of this.

Mr. Yorke Saville, of Darwen, has been appointed assistant manager of the Plymouth Corporation tramways.

The Council of Liverpool University have appointed Mr. G. E. Scholes, M.Sc., M.B.E., to the newly established Chair of Engineering—Thermodynamics of Heat Engines.

Mr. J. Smith, a former charge engineer in the Swansea tramway power station, and now holding a commission in the R.E., has been appointed shift engineer at Swansea Electricity Works at £305 10s. per annum.

Appointments Vacant.

A shift engineer is required for Accrington electricity department. Salary £254. Applications to the Borough Electrical Engineer.

An engineer is required by the Galway Electric Company, Ltd. Salary £300. Applications to Prof. Perry, 25, Stanley-crescent, London, W.11.

Applications are invited for 11 appointments as wireless operators in the Royal Indian Marine. Pay—Rs.200 per month on appointment, rising by triennial instalments to Rs.250 per month after nine years. Forms from the Secretary, Military Depot, Room 102, India Office, Whitehall, London, S.W.1. Applications by Feb. 29.

A whole-time teacher in electrical engineering and physics is required for the day school and evening classes at the L.C.C. School of Engineering and Navigation, Poplar. Salary £225 £315, rising to £330 by yearly increments of £15, thence by £[illegible] increments to £4[illegible] a year. Application forms from the Education officer, Victoria Embankment, W.C.2, and forms must be returned by 11 a.m., Feb. 23.

Tenders Invited and Accepted.

KING'S LYNN [illegible] Committee require tenders by noon Feb. 2[illegible] for the supply of [illegible].

MANCHESTER [illegible] Committee require tenders by Feb 25 for [illegible]. Specifications from Mr F. E. H[illegible], Town Hall, Manchester.

BELFAST Tramways Committee require tenders by Feb. 14 for the supply of electrical accessories, copper strip, lamps, insulating tapes, &c. Forms from the General Manager, Napier-street, Belfast.

[illegible] of the [illegible] NAVIGATION [illegible] COMPANY, LTD., [illegible], Mon., require tenders by 10 a.m. March 4, for six months' supply of stores, including electrical goods, ironmongery, oils, &c. Forms of tender from the Secretary.

The METROPOLITAN WATER BOARD require tenders by 11 a.m. on Feb. 20 for three, six or 12 months' supply of stores, including electric lamps, electric wire and accessories, oils, &c. Forms of tender from the Chief Engineer, South-place, Finsbury, London, E.C.2.

MANCHESTER Waterworks Committee require tenders by Feb. 21 for the supply and erection at Thirlmere of water turbine, dynamo, storage battery, booster, motor-generator, d.c. motors, starting panels and cables. Specifications from the Secretary, Town Hall, Manchester.

The Ministry of Communications (Director of Telegraphs and Telephones), ATHENS, require tenders by May 13 for supply of wooden poles, galvanised and brass wire, insulators, telephone cables, exchange equipment, &c. Specifications from the Ministry of Communications.

ABERDARE Urban Council invite tenders for one year's supply of stores for the electricity and tramways departments, including cables, meters, joint boxes, electric lamps, ironmongery, parts, &c. Forms from the general manager and tenders to the clerk (Mr. W. R. Morgan), Town Hall, Aberdare, by March 8.

The Electrical Committee of BRISTOL Corporation invite tenders for the supply and erection of one 2,000-kw. single-phase 2,200 volt turbo-generator, with condenser and auxiliaries. Specifications and forms of tender from the chief engineer and general manager, Mr. H. Faraday Proctor, M.I.C.E., The Exchange, Corn-street, Bristol, to whom tenders must be delivered by the 23rd inst.

ALDERSHOT Urban Council invite tenders for geared turbine and generator, condensing plant, circulating and other pumps, water-tube boiler and super-heater, and armoured, lead-covered, paper-insulated feeder and pilot cables. Tenders to the clerk, Mr. D. Llewellyn Griffiths, Municipal-buildings, Aldershot, by Feb. 17.

Tenders are invited for the supply and delivery in MELBOURNE of two 2,000-kw. rotary converters and h. t. and d.-c. switchgear. Specifications, &c., may be obtained from the Agents of the City Council, Messrs. McIlwraith, McEacharn & Company Proprietary, Ltd., Billiter-square-buildings, London, E.C.3. Tenders to the Town Clerk, Town Hall, Melbourne, by 2 p.m. April 12.

LINCOLN Corporation invite tenders for the supply and erection of an accumulator battery at St. Swithin's power station. Specifications from the consulting engineers (Messrs. Preece, Cardew & Rider), 8, Queen Anne's-gate, Westminster, S.W.1; and specifications can also be seen at the office of the city electrical engineer, Mr. Stanley Clegg. Tenders, on forms to be obtained from the Town Clerk's office, Guildhall, Lincoln, by March 2.

HAMMERSMITH (London) Borough Council invite tenders for the supply of electricity stores, including electric light sundries, fire bricks, insulated wire, cable ducts, joint boxes, meters, cable compound, engineering tools, steam packing, &c. Forms from the borough electrical engineer, Mr. G. G. Bell, and tenders to the Town Clerk (Mr. Leslie Gordon), Town Hall, Hammersmith, W.6, by 4 p.m., March 3.

Erith's Engineering Company, Ltd. (7[illegible], Gracechurch street, London), is furnishing, to the orders of Edinburgh Corporation, Erith Riley stokers which are much larger than any stokers hitherto made in any country, each stoker being no less than 33 ft. wide. They are also furnishing identical huge stokers to Shanghai electricity works, each stoker being assembled from standardised uniform self-cleaning retort units, set side by side in a straight walled furnace, under water-tube boilers normally evaporating no less than 80,000 lb. high-pressure superheated steam hourly. The coal is fed, the fires are sliced and the incombustible ash is continuously discharged without manual labour. The labour saving, contrasted with a battery of 12 Lancashire boilers, which need eight firemen per shift, for the identical steam-raising duty, is self evident; and the fully automatic Erith Riley stoker with the modern water-tube boiler gives a thermal efficiency representing also a substantial fuel saving, as well as the capacity to use low grade small fuels to the best advantage.

The latest Erith Riley stokers for Hull Corporation electricity works are exactly similar; but instead of being applied to one 80,000 lb. boiler each, they are applied to a pair of 40,000 lb. boilers, divided only by a partition wall, but allowing only half the capacity to be shut down at a time, while giving identical results; just as is the case with the Erith-Riley stokers of similar capacity at the Bow power plant of the Charing Cross Company, where the large boilers are set in pairs, but back to back.

While the above mentioned stokers are each six times as large as the first ones built by the company in 19[illegible]4, proportional results are attained with all makes and all sizes of water tube boilers using Erith-Riley stokers. Many important repeat orders are now in hand for home and Indian and Colonial electricity generating stations; while the French-built Erith-Riley stokers are also in extensive use on the Continent. The makers invite investigation into their fully automatic firing method.

STEPNEY (London) Borough Council has accepted the tender of the Metropolitan Vickers Electrical Company for the supply of a 10,000 kw. turbo-generator at £72,156, plus £1,750 for a guarantee of a deduction of 0.3 lb. in steam consumption from the figure in the tender. Messrs. Escher, Wyss & Company submitted two tenders at £79,204 (Oerlikon alternator) and £82,634 (Brown, Boveri alternator) respectively; and Messrs. Fraser & Chalmers (General Electric Company) and C. A. Parsons & Company also submitted tenders. Offers were invited for a 5,000 kw. set, but contractors were given the opportunity of also quoting for a 10,000 kw. unit. Fourteen firms submitted 19 tenders for the 5,000 kw., but only four firms sent in complete tenders for the 10,000 kw. set.

The Council has also accepted the tender of Babcock & Wilcox for the supply of two water tube boilers at £13,911. Only one tender was received, and two firms were unable to tender. An order has been placed with W. T. Henley's Telegraph Works Company for house service cable at £558, and with Messrs. Sutton & Company for 1½ miles of conduits and 2¼ miles of troughs and covers at £1,875 10s.

Business Items, &c.

The Import and Export Licensing Section of the Board of Trade has been removed to the ground floor of the offices of the Board at Great George-street, S.W.1. Telephone: Victoria 9,800.

The headquarters of the Profiteering Act Department of the Board of Trade have been removed to 22, Carlisle-place, Westminster, S.W.1 (telephone, Victoria 4173), but the Central Committee remains at 54, Victoria-street, S.W.1.

The partnership between Wm. Marples, Harry Bufton and Wm. Elliott, electrical engineers, 10, Porter-street, Sheffield, has been dissolved so far as concerns Wm. Elliott. Debts by Messrs. Bufton & Marples, who continue the business as Lee & Bufton.

The partnership between Arthur H. Clarke, Arthur C. Gregory Newcombe and Harry Hills (trading as Western Magneto Works, 188, Blythe-road, London, W.14, has been dissolved. Debts by Mr. A. C. G. Newcombe, who continues the business.

The partnership between A. H. Preece, Sir John F. C. Snell, J. H. Rider and J. H. Woodward carrying on business as Preece, Cardew, Snell & Rider, consulting engineers, 8, Queen Anne's-gate, Westminster, S.W., has been dissolved so far as concerns Sir John F. C. Snell. Debts by Messrs. Preece, Rider & Woodward, who will continue the business under the style of Preece, Cardew & Rider, at the same address.

The Ivor Electrical Company, Ltd., of 10, Kirby-street, Hatton Garden, London, E.C.1, notifies that it is now in a position to undertake repairs to electric motors, armatures, magnetos, &c., as it has every facility for such work, being specialists in the manufacture of electrical appliances.

Mr. G. B. Broughton, of the Birmingham office of the General Electric Company, has been appointed Manager of the Midland Branch of the Electrical Apparatus Company, in place of the late Mr. A. G. Way. The address of the branch officeis: Carlton House, High-street, Birmingham. Telegrams: Elapratus,Birmingham; Telephone: Central 7,478.

In an article on the A.W.P. welding process which appeared in our issue of Jan. 30 we mentioned that "an electrically welded vessel has recently been launched." We are asked to state that the Quasi-Arc process and electrodes were alone used in the construction of this vessel, and also on the coasting steamer which has just been launched from the Birkenhead yard of Messrs. Cammell, Laird & Co.

In the sale of plant and machinery on behalf of the Ministry of Munitions, which will take place at Wood lane, London, W., on March 4, 5 and 8 and following days, there are a number of lathes and tools, some electric motors, electric lighting sets, electric fans, lamps, batteries, telephone sets, &c. Catalogues from the auctioneers (Messrs. Herring, Son & Daw), 98, Cheapside, E.C. 2, or 312, Brixton hill, S.W.2, or from the officer in charge on the premises.

The great war has proved conclusively the urgent necessity for a departure from the old policy of piecemeal manufacture and for the adoption of repetition work and mass production wherever possible. By this means alone is it possible to hold one's own in the export markets and to combat the ever increasing tendency towards increased costs and as a corollary, high prices to the consumer. Co-operation in technical design, combined with scientific management, have proved of immense benefit in many industries. It is not surprising, therefore, to learn of the amalgamation of the interests of the ELECTRICAL APPARATUS COMPANY, LTD., and MESSRS. BRAY, MARKHAM & REISS. Both are specialists in the manufacture of motor control gear, and the joint enterprise will be run under the aegis of the E.A.C., but the technical management of the B.M.R. works will continue under Mr. E. N. Bray. It is hoped that the increased resources of the combination will result in greater efficiency all round, and a strong effort will be made to bring into service to a greater extent the excellent technical characteristics of B.M.R. apparatus for industrial purposes.

Liquidations and Bankruptcies.

Claims against the Electrical Company, Ltd., 6, Old Jewry, London, E.C., are to be sent by Feb. 21 to the liquidator, Mr. H. de Vaux Prougham, 33, Carey-street, W.C.2.

Brolt, Ltd., is being wound up for the purpose of reconstruction, and Mr. E. Bosley (Sharpe, Parsons & Company), 120, Colmore-row, Birmingham is liquidator. Claims to Mr. Bosley, by March 1.

An application for the discharge of Wm. Hy. Howard (lately trading as the Holborn Electrical Company), 17, Russell road, Finsbury Park, London, N., will be heard on Feb. 27 at Bankruptcy buildings, London, W.C.

Companies' Reports, &c.

The directors of the London Electric Railway Company recommend a final dividend on the ordinary shares of ⅝ per cent., making with the interim dividend of 1 per cent., a dividend for the year of 1⅝ per cent. (against 2 per cent.), carrying forward £20,942, against £23,664).

The directors of the City and South London Railway Company have declared a final dividend on the consolidated ordinary stock of 1 per cent., making with the interim dividend of 1 per cent., paid in August last, 2 per cent. for the year (as in 1918), carrying forward £19,750, against £24,367.

The directors of the North London Railway Company, after placing £10,000 to the general reserve, recommend a final dividend of 3¼ per cent. on the consolidated ordinary stock, making, with the interim dividend of 2¼ per cent., 5½ per cent. for 1919, against 4¾ per cent. in 1918), carrying forward £13,600.

The Underground Electric Railways Company of London, Ltd., announce that the revenue will enable them to pay the full interest to Dec. 31, 1919, on the six per cent. first per cumulative income debenture stock, and to pay interest at 1 per cent. on the six per cent. income bonds of 1948 for the half-year, with a carry forward of about £34,000.

The directors of the Metropolitan District Railway Company recommend a final dividend on the 5 per cent. second preference stock of 1½ per cent., making with the interim dividend of 2½ per cent., 4 per cent. for the year, carrying forward £22,098. The full dividend was declared on the second preference stock in 1918, £21,331 being carried forward.

For the year ended June 30, 1919, the profit of the Spanish and General Wireless Trust Company, was £5,500, with £483 brought forward. The credit balance is £5,983, and will be carried forward. It is proposed to convene an extraordinary general meeting for submitting a resolution to voluntarily liquidate the company and sell its assets for fully paid shares in a new company, with wider powers.

The directors of the Globe Telegraph and Trust Company, Ltd., announce a final dividend of 14s. per share, making 10 per cent. for the year. They also announced that 60,376 new ordinary shares will be issued at par in the proportion of one for every three already held, so as to enable the company to take up its proportion of the new shares issued by the Eastern, Eastern Extension and Western Telegraph Companies.

The directors of the Central London Railway Company recommend a final dividend on the undivided ordinary stock of 1½ per cent., making with the interim dividend of 2 per cent. 3½ per cent. for 1919 (against 4 per cent.); a final dividend on the preferred ordinary stock of 2 per cent., making with the interim dividend 4 per cent.; and a dividend on the deferred ordinary stock of 3 per cent. (against 4 per cent.), carrying forward £11,762, against £17,485.

The Central Electric Supply Company, Ltd., reports that after transferring £22,766 to depreciation fund, and writing off £400 for discount on issue of debenture stock there was a loss of 10s. on the working for 1919. Deducting the amount from the credit balance of £8 17s. brought forward, the credit balance of £8 7s. is to be carried forward. Last year £22,253 was placed to depreciation and sinking fund; £400 written off discount on debenture stock and £8 17s. forward.

An extraordinary meeting of the General Electric Company, Ltd., will be held to-morrow for the purpose of passing resolutions consolidating the 1,665,790 issued preference and 144,210 of the unissued preference shares into "A" preference shares and making the 1,800,000 preference shares at present unissued 7½ per cent "B" cumulative preference shares. The capital will then be £6,000,000, divided into 1,800,000 6½ per cent. "A" cumulative preference and 1,800,000 7½ per cent. "B" cumulative preference shares and 2,400,000 ordinary shares of £1 each.

At the meeting of the Dublin United Tramways Company (1896) Ltd., on Tuesday, it was reported that the amount available for division was £148,271. Interim dividends amounting to £24,150 were paid in August, 1919, and it was decided to pay a dividend at the rate of 6 per cent. per annum on the preference stock for the half-year ended Dec. 31, and a final dividend at the rate of 7 per cent. per annum, less tax (making 6 per cent. for the year) on the ordinary stock for the same half-year, together with a bonus of 1s. 6d. (tax free). A sum of £30,000 was placed to deferred renewals of rails, £27,000 to deferred renewals of cars, £12,321 was added to general reserve and £4,000 written off price of investments. The dividends, bonus and sums set aside absorbed £131,191 and left £17,080 3s. 4d. to be carried forward.

The directors of the Automatic Telephone Manufacturing Company, Ltd., announce that the earnings will be insufficient to allow payment of any dividend on the ordinary shares. In a circular issued to the shareholders it is stated that many of the patents have expired and others have but a comparatively short life, these patents representing £240,000, or 40 per cent. of the capital. There are negotiations with an international syndicate for the formation of a new concern, under the title of International Automatic Electric Company, to acquire the right to carry on business in 11 European countries where the present company has no such rights. The new company will have a capital of £920,000 (260,000 7 per cent. cumulative preference, 360,000 ordinary and 300,000 deferred shares of £1 each). The new preference shares will be exchangeable for those now in existence, while the whole of the new deferred will go to the syndicate as consideration for the provision of additional capital for extensions up to £100,000, and manufacturing orders carrying a fixed percentage of profit from countries outside the United Kingdom to the following minimum amounts: £100,000 in 1920, £150,000 in 1921, and of £200,000 per annum in 1922 to 1927 inclusive.

The half yearly meeting of the [illegible] Company took place on Tuesday, when it was reported that for the half year ended Dec. 31 the surplus of receipts over expenditure was £7,177 with £1,757 brought forward. The total was £8,93[illegible]. After deducting interest on motrgages, &c., the balance of £7,58[illegible]. A dividend was declared on the ordinary shares at the rate of 5 per cent. per annum, making 5 per cent. for the year, £1,400 was placed to reserve for renewals, depreciation, &c., leaving to be carried forward £2,237. The traffic receipts increased by £4,850 compared with the corresponding half year of 1918, and for the whole year the increase was £7,238.

The gross receipts of the Metropolitan Railway Company for the year 1919 amounted to £1,712,952 and the expenditure to £1,279,074. After taking into account the miscellaneous receipts from rents, &c., the total net income is £637,328. After adding balance from 1918, deducting interest and other fixed charges, and also the dividends on the preference stocks, the available balance is £300,680. An interim dividend of 1 per cent. per annum was paid on the ordinary stock for the half year ended June 30, and the directors recommend payment of a final dividend at the rate of 1½ per cent. per annum for the half year ended Dec. 31, making 1¼ per cent. for the year, leaving £19,864 to carry forward. A sum of £40,000 has been transferred to general renewals fund, compared with £20,000. Although there has been a large increase in the traffic, the expenditure has grown in a much greater ratio by reason of the concessions made by the Government to the staff and of the higher cost of all commodities, especially coal, and consequently the amount received from the Government under their guarantee is considerably greater than in 1918. To meet the heavier expenditure there is no alternative but to increase passenger fares, many of which were not subject to the general advance of 50 per cent. made in 1917. In view of the expansion of traffic over all sections of the railway, additions to the rolling stock and electrical plant have become imperatively necessary. Orders have been placed for the construction of a number of new trains and locomotives, and negotiations are proceeding for additional generating plant.

The net profit of the Yorkshire Electric Power Company for 1919, after payment of mortgage and other interest, was £54,133, against £46,536 in 1918 and £33,258 in 1917, and with £10,224 brought forward the total is £64,358. The directors recommend payment of a dividend at the rate of 6 per cent. per annum on the cumulative preference and 8 per cent. on the ordinary shares (against 9 per cent.), the transfer of £15,000 to general reserve (making the sum £74,000), carrying forward £17,596. Notwithstanding the change from war to peace conditions, the substantial progress made during past years has been maintained. It is proposed in future to pay dividends half-yearly on the ordinary shares, the interim dividend on both classes being payable in August.

A feature of the company's development, which the directors note with satisfaction, is the growing practice on the part of power users to invest capital in the company, in place of installing small units of power plant in their works for their sole needs. The investments of the company's consumers and of directors of companies taking supply now exceed one-fifth of the issued capital. There has been during the year a large growth in the revenue on account of energy supplied both to individual power users and to authorised distributors. The continued increase in the cost of coal has emphasised the advantages of the company's supply to power users, and additional generating plant is required to meet the large and increasing demands for current. A commencement of bulk supply has been made to Spenborough and Elland Urban Councils, and terms have been agreed with the Corporations of Batley, Dewsbury, Todmorden and Wakefield, from which a considerable demand will arise. The report states that the Electricity (Supply) Act introduces certain legislative amendments which should facilitate future developments.

In the report of the Melbourne Electric Supply Company, Ltd., for the year ended Aug. 31, 1919, it is stated that the operations of the company during a portion of the period were adversely affected by the strike of seamen. Owing to the shortage of fuel, the authorities imposed drastic restrictions in the use of electricity, particularly in the supply of power for industrial purposes. The gross profit from the Melbourne and Geelong undertakings amounted to £180,161, compared with £161,887 for the previous year, an increase of 11 per cent. After payment of management and general expenses at the London head office, and after providing for the debenture and gold bond interest, &c., the directors have written £1,134 off sundry items of capital expenditure, placed £10,000 to reserve for income tax and excess profits duty, £20,000 to gold bonds redemption account and £20,501 to general reserve, leaving a balance of £78,621. Deducting the two half-yearly dividends on the 7 per cent. first cumulative preference shares, the interim and final dividends on the consolidated ordinary stock (making 10 per cent. for the year), the year's balance was £15,201. With £34,849 brought forward, the total credit balance of £50,050 15s. was carried forward. The total net capital expended on the Melbourne and Geelong undertakings (including tramways) is now £1,744,092, an increase of £212,378.

At Melbourne there are 42,430 consumers (against 36,870), and the total connections are 66,507 kw. (including 30,318 H.P. in motors); and at Geelong there are 3,374 consumers (3,148), and the connections are 5,497 kw. (including 2,415 H.P. in motors). The area of the suburban districts in Melbourne covered by the company's statutory powers is 92 sq. miles, with an estimated population of 407,000; and a supply of electric light and power is now available in 659 miles of streets, an increase of 36 miles during the year, these figures being exclusive of the bulk supply which the company is affording to the local authorities of several outlying districts. The power supply increased by 10 per cent., the total connections (including lamps, motors, heating, cooking and other apparatus) increased by 12 per cent., and the total units sold by 7 per cent.

New Companies.

BROLT, LTD. (163,372). Reg. Jan. 28, capital £350,000 in £1 shares. Objects: To take over the business of electrical and mechanical engineers, and manufacturers of and dealers in electrical apparatus, plant, &c., carried on by Brolt, Ltd. (incorporated in 1911), at Birmingham and elsewhere. First directors are: B. Brooks, A. C. Johnson, A. Brown, E. Brown and H. W. Alexander.

CAR LIGHTING SET COMPANY, LTD. (162,890).—Private company. Reg. Jan. 16, capital £5,000 in £1 shares, to carry on the business of manufacturers, suppliers, installers and repairers of lighting, starting and driving apparatus, &c. First directors are C. W. Akers, A. J. Austin, and W. Blankara (all permanent). Reg. office: 36, Maiden lane, Strand, W.C.2.

GENERAL WELDING COMPANY, LTD. (10,881).—Private company. Reg. in Edinburgh Jan. 9, capital £10,000 in £1 shares, to carry on in Glasgow the business of welders by oxy-acetylene and other autogenous processes, &c. First directors are R. Baillie, A. Paton and P. Linn. Reg. office: 19, Muirhouse-street, Glasgow.

HODGSON & PARTNERS, LTD. (163,670). Private company. Reg. Feb. 4, capital £5,000 in £1 shares, to carry on the business of founders' electricians, decorators, and any business in which electricity may be used, and to acquire business of F. Hodgson. First directors are: F. Hodgson, A. E. Wellman, H. J. Kirby and H. T. Smith. Reg. office: 12, Heath-street, Hampstead, N.W.

ICENI ENGINEERING COMPANY, LTD. (163,037). Private company. Reg. Jan. 29, capital £3,000 in £1 shares, to carry on in Letchworth and elsewhere the business of mechanical and electrical engineers, &c., and to adopt an agreement with T. F. Wild. First directors are C. F. Ball, J. W. E. Powell, G. C. Swanson, E. J. Simmons and C. H. Jolley.

NATIONAL ELECTRIC SIGNS, LTD. (163,301). Private company. Reg. Jan. 26, capital £5,000 in £1 shares, to carry on the business of electric and illuminated sign manufacturers as formerly carried on by H. H. Scott and G. I. Scott, as the National Electric Sign Company. Reg. Office: 61 and 62, Lincoln's Inn-fields, W.C.

PAXTON'S (CARDIFF), LTD. (163,221).—Private company. Reg. Jan. 23, capital £3,000 in £1 shares (1,000 founders), to take over, as from Feb. 1, 1919, the business of electrical engineers carried on by A. Paxton and H. W. C. Hinchley at Regal Works, Whitchurch-road, Cardiff. First directors are: A. Paxton and H. W. C. Hinchley.

SMALL POWER DYNAMO AND MOTOR COMPANY, LTD. (163,409). Private company. Reg. Jan. 28, capital £5,000 in £1 shares. Objects: To take over the business of electrical and mechanical engineers, carried on by A. Radcliffe and F. S. Blakey as the Small Power Dynamo and Motor Company. Permanent directors: A. Radcliffe and F. S. Blakey. Reg. office: 129, Old-lane, Higher Openshaw, Manchester.

W. B. & J. BAIN, LTD. (10,912). Private company. Reg. in Edinburgh Jan. 21, capital £7,000 in £1 shares, to acquire the business of general and electrical engineers and merchants, agents, &c., carried on as W. B. & J. Bain. First directors are: W. B. and J. Bain. Secretary: A. McLean. Reg. office: 52, Robertson street, Glasgow.

Prices of Metals, Chemicals, &c.

TUESDAY, Feb. 10.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£128 10 0	£3 10 0	—
Electro Wirebars...	,,	£132 0 0	£7 0 0	—
H.C. wire basis......	per lb.	1s. 5$\frac{9}{16}$d.	$\frac{13}{16}$d.	—
Sheet	,,	1s. 6½d.	⅝d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 9$\frac{3}{16}$d.	$\frac{13}{16}$d.	—
Brass 60/40—				
Rod, basis	,,	1s. 1¼d.	⅜d.	—
Sheet, basis	,,	1s. 4¾d.	¼d.	—
Wire, basis	,,	1s. 4¼d.	⅜d.	—
Iron—				
Cleveland Warrants	per ton	£9 2 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£39 0 0	—	—
Lead Pig—				
English	,,	50 5 0	£1 15 0	—
Foreign or colonial	,,	49 17 6	£2 7 6	—
Tin—Ingot	,,	392 15 0	£8 15 0	—
Wire, basis	per lb.	0 4 10	1d.	—

Salammoniac.—Per cwt. 95s. and 90s.
Sulphur (Flowers).—Per ton £22.
,, (Roll Brimstone).—Per ton £22.
Sulphuric Acid (Pyrites, 168°).—Per ton £7 18s. 9d.

Copper Sulphate.—Per ton £50.
Boric Acid (Crystals).—Per ton £74.
Carbon Bisulphide.—Per ton £56.
Sodium Bichromate.—Per lb. 9d.
Sodium Chlorate.—Per lb. 6d.

Rubber.—Para fine, 2s. 7d.; plantation 1st. latex 2s. 9¼d. lb.

Shellac.—T.N. Orange, 860s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber figures by W. T. Henley's Telegraph Works, Company.

Thirty-Seven Years Ago.

[From THE ELECTRICIAN, Feb. 10, 1883.]

MORE GAS (from the Leader). Whatever angry feelings may at first have been aroused among the owners of gas property by the intrusion of the electric light must now, we should imagine, give place to sentiments nearly akin to gratitude. The scare which temporarily depreciated the price of gas shares to about half their market value has been followed by an equivalent rise and a steady tone which is not likely to give way to panic again in a hurry. But this is not all: the competition of the electric light has created a demand for better illumination, and this means the consumption of more gas. The public, we have heard it stated, have become quite demoralised in the matter of street lighting, and, having tasted the luxury of a well lighted thoroughfare, will not again submit to anything less luxurious in place of it. We are not in the secrets of the gas manufacturers, but nobody can walk along either of the two great footways which lead from the City to the West End without feeling perfectly convinced that the consumption of gas must have greatly increased since electricity essayed to extinguish it. The gas corporations are not likely to be making this great display experimentally, or at a loss, as is spitefully alleged of one or two electric lighting companies; and we may, therefore, conclude that the receipts of the former have of late been greatly augmented. For this they have to thank the electric light, and we hope they are grateful. The exhibition of gas lighting appliances at the Crystal Palace is another boon which the gas companies owe to the electric light. Nominally, it is a competitive exhibition between the two systems of lighting, the old and the new; but in reality the gas people have the field almost to themselves, some well-known electric lighting engineers even going so far as to exhibit gas lighting appliances only, and not their electric lighting inventions.

The few exhibits of electrical illumination on view are of little account, and are not calculated to depress the spirits of shareholders in the old companies. Whether this is a wise piece of self-denial on the part of the electric lighting interests time alone will show; certain it is the gas interests are just now in the ascendant at the Crystal Palace, and nobody can blame them for making the most of the occasion. There are several useful lessons to be learnt at this exhibition, however, which those who are interested in the future of the electric lighting may profit by, and we will mention a few of them. First of all, gas is here at its best. We see what it can do. Not that anybody doubted we could have more light by consuming more gas; but the gas engineers appear to have thought it necessary to remove the doubt if it existed. At a profligate expenditure of gas, they have lit up this vast edifice splendidly.

TELEPHONIC COMMUNICATION WITH LIGHTHOUSES.—Mr. Chamberlain was asked at Swansea last Friday whether the Government would assist the establishment of a telephone wire between Lundy Island and the mainland. It is understood that Lloyd's have now determined to erect one within six months, provided they can obtain a subsidy of £600 a year from merchants and others on the Channel.

THE LIGHTING OF BATH. The Town Council of Bath have awoke to the fact that the present lighting of the streets is "discreditable." To improve it they are going to substitute 6 ft. for 4 ft. burners, and introduce large gas lamps at certain points, and for this they are going to pay £57 more per annum than at present. The Town Council are by no means unfavourable to electric lighting.

ELECTRIC LIGHTING IN BUDAPEST.—Electric lighting is progressing in this gay Hungarian town. We hear that Herren, Ganz & Company are to light up the National Theatre by means of 1,000 Swan lamps; that they are already fitting up 200 similar lamps in a corn mill there; and that the Café Steenassger, on the Corso, is lighted by means of lamps, the invention of Herr Zipernowsky, whose patronymic does not sound Hungarian.

THE COST OF ELECTRIC LIGHTING.—Champagne has not yet been sold for the price of beer, says the "Engineer," but there can be no doubt that money is made by champagne growers, and there is good reason to believe that the demand for it is practically unlimited. We may regard electric lighting as representing champagne, whilst gas stands for beer, and feel confident that the public will willingly use the former, even though the price should be higher than gas.

ELECTRIC RAILWAYS.—Owing to the sudden cessation of Court festivities at Berlin, consequent on the death of the Emperor William's brother, His Majesty's physicians have been somewhat at a loss how to provide suitable recreation for him. A happy thought seems to have suddenly occurred to them, however—viz., that of interesting scientific lectures. No sooner said than done, and accordingly the first of a series of such lectures was given before the Emperor and other members of the royal family by Dr. Werner Siemens a few days ago. His subject was electric railways in general, and the elevated electric railway, with which he hopes to provide Berlin, in particular. His audience are said to have listened very attentively.

INTERNATIONAL ELECTRICAL EXHIBITION, VIENNA. We stated in a recent note that an International Electrical Exhibition will be held in Vienna, under the patronage of the Austro-Hungarian Government, in the months of August, September and October next. At the request of the Austrian Minister of Commerce, and of the Managing Committee of the Exhibition, the Council of the Society of Telegraph Engineers have appointed a committee to receive applications for space from British exhibitors, and for promoting generally the formation of a British section. Applications should be made as early as possible, and should be addressed to the Secretary of the Society of Telegraph Engineers and of Electricians, 4, The Sanctuary, Westminster, S.W.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF
ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE
ESTABLISHED 1861.

No. 2,179. [Vol. LXXXIV. No. 8.] FRIDAY, FEBRUARY 20, 1920 PRICE SIXPENCE.
By Post, 7d. Abroad, 9d

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Notes.

The Electricity Commissioners.

As foreshadowed in last week's issue of THE ELECTRICIAN, it is now officially announced that Sir JOHN SNELL has been appointed chairman of the Electricity Commissioners under the Electricity (Supply) Act, and that Mr. HARRY BOOTH, of the Board of Trade, and Mr. A. PAGE, the general manager of the Clyde Valley Electrical Power Company, have been appointed Commissioners. In addition, Mr. W. W. LACKIE, manager-engineer of the Glasgow Corporation, has also been appointed a Commissioner. It cannot be said that these appointments will cause any great surprise, as most of them have been known unofficially for some time, but Government Departments love both mystery and delay, and what might (as far as any one can see to the contrary) have been done some weeks back has now been done at last. Nor will anyone be disposed to criticise harshly the appointments now that they have been made. In a recent issue we laid down that the Commissioners must have the qualities of sympathy, outlook and tact, while, as far as the engineering Commissioners are concerned their qualifications are prescribed in the Act itself. We feel certain that Sir JOHN SNELL is the right man in the right place. He has had wide engineering experience, and what is more important, wide Parliamentary experience. Moreover, he possesses the qualities mentioned above in a high degree. Mr. BOOTH represents the official element. Some hard things are said about officialdom, and some hard things have been said about Mr. BOOTH. But while our country is governed and administered as it is officials are necessary, and his fellow Commissioners will no doubt find his experience useful in carrying out their work. It may be taken that Mr. LACKIE represents the municipal side and Mr. PAGE the privately-owned side of electricity supply. It is curious, and perhaps a little unfortunate, that they should both come from Glasgow, but it is becoming so usual for Englishmen to be ruled by Scotchmen and Irishmen that we should now be surprised if a different procedure were followed. Another criticism is that Mr. PAGE's experience of the operation of privately-owned undertakings is short. Before 1917 he was for many years with the Glasgow Corporation, so that it might have been better, and by no means impossible, to have appointed some one more intimately connected with a power or electricity supply company. The appointments now made leave one vacancy in the ranks of the Commissioners. We sincerely hope this will be filled by a financial expert. Finance is a great rock in the stream of electrical progress, and it will require much care if it is to be steered past in safety. Engineering knowledge and familiarity with official procedure will not suffice to lead us to success if the necessary control in this respect is lacking. All these statements are made in no spirit of captiousness, but with a very genuine desire that the Commissioners should carry out their duties with the greatest possible success. They have a difficult time before them, they will not succeed in pleasing everybody (they will even be foolish if they try), but if they tackle their task in a spirit of high endeavour (as we feel sure they will) they will carry with them the good wishes of all who desire to see the germ of progress working in the electrical industry.

Possibilities—Pleasant and Unpleasant.

THE Electricity Supply Act will, in fact, mean, we all hope, a renaissance in the electric supply industry. Many of the old rigidities which "cribbed, cabined and confined" undertakings will melt away under the sunbeams of the easy procedure inaugurated. All this is to the good of everyone concerned. But there is another side. The new conditions may give rise to a recrudescence of those speculative ventures which characterised the early days of the industry. The fact that privileges are now made easier of attainment may tempt the financial hawk to hover over the tempting bait. It will be the duty of the Commissioners to give these birds of prey short shrift. The intention of the Act is to give the present undertakers in a district a chance of autonomous self-development. What privileges there are, are meant for them. Further, if ever there comes a case for the Commissioners to adjudicate upon, as between rival claimants, it should be fully understood that preference must be given to that undertaker who has the best record as a servant of the public, and who has carried out most faithfully his duties to consumers. To take a case in point. Under the Act an abbreviated procedure is prescribed for obtaining Provisional Orders. This means, of course, that they can be obtained with greater facility and with less expense. It is obvious that more caution will have to be observed in granting orders otherwise we shall see them snapped up by people who have no intention of working the Order, but merely wish to sit on it until a purchaser comes along, or to make some other nefarious use of it. A traffic in

Orders or in Special Acts, should be prevented at all costs. The Commissioners will need to be very alert to checkmate these "snappers-up of unconsidered trifles." For instance, as bearing on this point, in the past out of 1,221 Orders granted by the Board of Trade, 370 have been revoked or repealed, so that even under the unfavourable conditions then obtaining a certain amount of speculation went on. Altogether it is certainly in the interests of private enterprise that its reputation as opposed to municipal ownership, should be delivered from the taint which any such abuses as we have mentioned, must inevitably give to it.

"London Traffic Combine" Statistics.

Those interested in the London traffic problem may be divided into three classes. The large class who considers the public is being fleeced by a gigantic trust or, in other words, that the many are obliged to travel expensively and uncomfortably in order that a few capitalists may line their pockets and luxuriously proceed in Rolls-Royces; the small class of shareholders who know that the dividends they get are meagre, when not actually non-existent; and the largest class of all, which finds travelling more and more reminiscent of a moving Black Hole of Calcutta. To all three of these classes the statistics recently issued by the London Electric Railway authorities will bring cold comfort. Nevertheless, they are worth examination. As is well known, the so-called traffic combine includes all the underground electric railways of London, except the Metropolitan and the Great Northern & City Railways. It also includes the General Omnibus Company, but not the various tramway undertakings or the suburban lines of the trunk railway companies. In considering these statistics the introduction of the General Omnibus Company is an added complication both as regards costs and figures for passengers carried, but we have thought it best to include them as they have a bearing on the problem as a whole.

Extraordinary Figures.

For the year ended December 31, 1919, the total traffic receipts amounted to £9,676,839, an increase of £2,419,829 over those in the previous 12 months. During the same period the operating expenses were £8,179,598, or an increase of £2,645,983 over the figure reached in 1918, so there is not much potential wealth for shareholders in that. The charges for interest, &c., were, however, slightly lower, and an increased amount was paid into the renewals fund. This expenditure, together with payments on the guaranteed and preference stocks, leaves £614,305 available for dividends and reserves, or £118,030 less than last year, giving the ordinary shareholders the princely return for their money of $1\frac{5}{8}$ per cent. Turning to the traffic side, we find that the total number of passengers carried reached the enormous figure of 1,073,392,518 no less than 170,510,132 more than in 1918, and 243,258,338 more than in 1913. It, therefore, seems that to say the Londoner has acquired the travelling habit is to understate the case. It is more than a habit—it is a hobby. But this in itself has not brought wealth to the companies, though the average fare per passenger has risen from 1·45d. in 1913 and from 1·80d. in 1918 to 1·99d. in 1919. Curiously enough this enormous increase in passengers has been done on a total smaller car-mileage than in 1913, but this is mainly due to a reduction of no less than 14,103,168 car-miles in the omnibus miles, the railway mileage having increased in every case during that period, except on the City & South London Railway. It is, therefore, obvious that the enormous increase in the number of passengers travelling has not brought with it anything like a corresponding increase in prosperity, and that the Traffic Combine has made out a good case for increased fares.

Higher Tube Fares.

An element of humour is introduced into this attempt to obtain powers to increase the fares by the support which is being given to the proposal by the Executive of the National Union of Railwaymen. As was to be expected practically every other trade organisation is strongly opposed to any increase in the ordinary railway fares or to the abolition of the specially cheap fares granted to workmen. The National Union of Railwaymen has, however, taken up the attitude that the present financial position of the companies prevents its members benefiting under the recent settlement, and that, whilst in no way departing from the declared policy of the union on the nationalisation question, it considers that while the present system of wages lasts it has no alternative but to support the Bill. In a recent issue we published an article by Mr. W. J. Hiscox, in which he referred to the detrimental effect which this increase in fares would have on the supply of labour in the London engineering trades. While accepting his point of view, we think, however, that it is time that the fare question in London should be placed on a more satisfactory financial basis. In the days when the workman was assumed to be earning a relatively lower rate of wage than that obtained by other classes of the community it was only right that he should be given some relief when it was necessary for him to travel long distances to his work. That time has now passed, and there is no reason why the meanest worker, like every other passenger, should not pay his fair share of the cost of transport. We, therefore, find ourselves, somewhat unusually, in agreement both with the railway companies and with the National Union of Railwaymen, though for reasons different from both.

Tragi-Comedy at Liverpool.

The situation in the electric wiring trade at Liverpool seems to be increasing rather than decreasing in gravity. And, we fear, unless saner counsels prevail a deadlock will soon be reached, and that we shall have to record another trade dispute, which could have been avoided if matters had been handled a little more tactfully. It will be remembered that last autumn the employers and the Electrical Trades Union in the Mersey area came to an agreement through the District Joint Industrial Council on future rates of pay and working conditions. This agreement was then submitted to the National Joint Industrial Council for ratification. The employers on the latter council by a majority decided to veto it, but the trades unions interested refused either to veto it or to ratify it. Not having been vetoed the resolution was operative, according to the Trades Union view. The Liverpool employers, however, stated that much against their will they were prohibited by the National Employers' Federation from carrying out the agreement they had entered into, and it is now contended that, although the constitution gives only the power of veto, no district decision ought to become operative until it has been ratified by the National Industrial Council. As the result of this discussion on procedure the Trade Union representatives have withdrawn from the Council, and, to adopt their phrase, have "put the new rules into force," by refusing to work except under the new conditions. In this attitude they are being assisted by a number of employers who are not members of the National Federated Electrical Association, and by a certain number who are. The Trades Union have temporarily relaxed their limitations on the working of overtime, with a view apparently to playing off those who have complied with the rules of the Council against those who have not. At the same time they have asked for still further increases in allowances, and Mr. L. G. Tate, general secretary of the National Federated Electrical Associations, has issued a circular appealing to members to make a levy to finance a possible protracted dispute. Indeed, it would really seem as if both sides were spoiling for a fight under the mistaken notion that only by fighting can they bring the other side to reason. Primarily the fault would seem to lie with the National Industrial Council. For the District Councils have full powers by their constitution to settle local wages, hours and working conditions without ratification. This they had done in this case before the National Council came upon the scene. However, this is no time for apportioning the blame, the damage has been done, and the urgent matter is to repair it before it is too late. But we are afraid this will not be done unless a more conciliatory spirit is shown on both sides.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

On page 188 we publish the first part of an article on "The Calculation of Track Pressure Drop and Track Losses on Direct Current Electric Railways," by Mr. F. F. P. Bisacre. Up to the present there has been very little information published on the mathematical side of these questions and the author has, therefore, dealt with the subject from this point of view in order to be of assistance to those who may have to lay out new electric railways.

Messrs. S. Q. Hayes and W. A. Coates contribute an article on "Large Outdoor Switches and Transformers" (page 190) in which they discuss the American practice of using outdoor transformers and switchgear for all pressures above 44,000 volts. The way in which the necessary climatic conditions affect the design and construction of this apparatus are dealt with.

On page 193 we give an abstract of a Paper on "The Protection of Alternating Current Systems without the Use of Special Conductors," which was read before the Institution of Electrical Engineers by Major Kenelm Edgcumbe. In this Paper he calls attention to the paramount necessity of maintaining a continuous supply, and gives an historical account of what has been done in this direction with relay system of protection.

On page 195 we publish our usual serial article on the progress that has been made with electrical heating and cooking apparatus.

On page 196 we give a preliminary account of the British Industries Fairs which will be opened next week at Birmingham and at the Crystal Palace. At the former of these a good deal of interesting equipment of an engineering nature will be shown.

On page 198 we give an account of the National Conference of Manufacturers and Producers which was recently held in London. At this Conference a large number of resolutions dealing with questions of supreme importance to trading interests were passed and an interesting discussion took place.

On page 198 we conclude our account of the electrical exhibits at the Ideal Home Exhibition at Olympia.

Our leading article deals with certain phases of the problem of how best to bring electric cooking and heating apparatus to the public notice (page 201).

On page 202 we publish a short illustrated biographical account of the three engineering Electricity Commissioners who were last week officially appointed to carry out the provisions of the Electricity Supply Act.

Arrangements for the Week.

FRIDAY, Feb. 20th (to-day).

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Resumed discussion on "Recent Advances in Utilisation of Water-Power," by Mr. E. M. Bergstrom.

Institution of Electrical Engineers.—Students' Meeting.

7 p.m. At Faraday House, Southampton-row, London, W.C. Discussion on "State Ownership v. Private Enterprise," to be opened by Mr. A. Serner.

Junior Institution of Engineers.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper on "Obscure Points in the Theory of the Internal Combustion Engine," by Prof. F. W. Burstall, M.Sc.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "British Crop Production," by Dr. E. J. Russell, F.R.S.

SATURDAY, Feb. 21st.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "Positive Rays," by Prof. Sir J. J. Thomson, O.M. (Lecture I.)

Birmingham and District Electric Club.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Paper on "Electric Vehicles," by Major R. V. C. Brook.

MONDAY, Feb. 23rd.

Institution of Electrical Engineers.—North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle. Lecture on "Some Magnetic Problems," by Mr. L. H. A. Carr.

Bradford Engineering Society.

7.45 p.m. At the Technical College, Bradford. Lecture on "Induced Draught for Boiler Installations, with Special Reference to the 'Prat' System," by Major S. Utting.

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Recent Research in Cellulose Industry," by Mr. C. F. Cross, F.R.S. (Lecture II.)

TUESDAY, Feb. 24th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "Magnetic Susceptibility," by Prof. E. Wilson. (Lecture II.)

Institution of Electrical Engineers.—North-Western Centre.

7 p.m. At the Engineers' Club, Manchester. Informal discussion on "Electricity Supply Tariffs."

Illuminating Engineering Society.

8 p.m. At the Society of Arts, John-street, Adelphi, London, W.C. Discussion on "Lighting Conditions in Mines, with Special Reference to the Eyesight of Miners," opened by Dr. T. Lister Llewellyn.

WEDNESDAY, Feb. 25th.

Industrial League and Council.

5.15 p.m. At the Carpenters' Hall, Throgmorton-avenue, London, E.C. Subject: "Trade Unionism and Output," by Mr. T. E. Naylor.

Paisley Association of Electrical Engineers.

7.30 p.m. At the Y.M.C.A. Buildings, 25, High-street, Paisley. Paper on "Historical Development of the Design of Electric Generators," by Mr. A. M'Crorie.

Industrial League and Council.

7.30 p.m. At the Conference Hall, Central Hall, Westminster, London, S.W. Subject: "Debate on Profit Sharing," by Messrs. E. W. Mundy and H. V. Roe.

Institution of Electrical Engineers.—South Midland Centre.

7.30 p.m. At the Birmingham Library, Margaret-street, Birmingham. Paper on "Transformers for Electric Furnaces," by Mr. J. L. Thompson, M.Sc.

THURSDAY, Feb. 26th.

Institution of Electrical Engineers.

5 p.m. At the Royal Society of Medicine, Wimpole-street, London, W. Joint Meeting with the Rontgen Society and the Electro-Therapeutic Section of the Royal Society of Medicine. Papers to be read: "On the Efficiency of High-Tension Transformers as Used for X-Ray Purposes," by Dr. R. Morton; "The Problem of Interrupted and Fluctuating Currents," by Major C. E. S. Phillips, O.B.E., and "High-Tension Transformers," by Mr. R. S. Wright.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. At the University, Liverpool. Lecture on "Wireless Telegraphy," by Prof. E. W. Marchant, D.Sc.

FRIDAY, Feb. 27th.

Physical Society.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers on "The Balancing of Errors," by Mr. T. Smith, B.A.; "Notes on the Testing of Bars of Magnet Steel," by Dr. N. W. McLachlan; "On the Forces Acting on Heated Metal Foil Surfaces in Rarefied Gases," by Mr. G. D. West, M.Sc.: and Exhibit of Crystal Models, by Miss N. Hosali.

Institution of Electrical Engineers.—Liverpool Students' Sub-Centre.

7.30 p.m. At the University, Liverpool. Paper on "Central Station Boiler Practice," by Mr. K. Habershon.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Defects Found on Inspection of Boilers," by Mr. R. H. Kenyon.

Junior Institution of Engineers.—Sheffield Section.

7.30 p.m. At the Cutlers' Hall, Sheffield. Paper on "Scientific Instruments," by Mr. J. A. Swift.

Wireless Society.

8 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Address on "Some Wireless Wonders," by Mr. A. A. Campbell Swinton, F.R.S.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "Problems of Lubrication," by Mr. W. B. Hardy, F.R.S.

The Calculation of Track Pressure Drop and Track Losses on Direct Current Electric Railways.

By F. F. P. BISACRE, M.A., B.Sc., A.M.Inst.C.E.

In the design of an electric railway, two important considerations are the *pressure regulation* of the distribution system between the trains and the sub-stations, and the losses of energy therein—shortly, the *track losses*. On these two questions the main features of the electrical layout of the distribution system hinge.

Unfortunately there is little, if any, information published on the mathematical side of these questions. They depend on the conditions under which the railway operates, such as the train service, current per train, distance between sub-stations, sub-station pressure, line conductivity, &c. Experiments are difficult to make. Theoretically, if every motor equipment or train on a given system or section of a system were fitted with a recording voltmeter and integrating watt-hour meter, and every sub-station with recording voltmeters and watt-hour meters, some definite data could be obtained as to regulation and track losses; but the expense of such a test would be great, and to be of real value, such tests would have to be supplemented by a great deal of other information relating to the system. It is essential to know what regulation may be expected on a new layout, for, if the regulation be bad, the trains will not run to time, contactors may not operate properly and train lighting will be irregular and dim. It is not unusual to find on existing railways lengths of track where the conductivity of the track circuits has been improved by means of either extra aerial conductors or additional rails on the ground. In laying out a new electric railway, the regulation and track losses must be arrived at in some way. The general features of the layout, such as positions of sub-stations, track conductivity to be used and so on, being settled, the proposed layout is sometimes compared with that of a *similar* railway which carries a comparable traffic. More often, however, no comparable system can be found relating to which complete data are available. When this is so, calculations must be made, and it is with these calculations that this article deals.

Pressure Drop Calculations.

Consider the sub-stations O and O' (Fig. 1) distant L miles apart. Let trains distant d miles apart be travelling from O to O' at uniform speed v miles per hour.

Consider the moment when train A is at O. The section $O\,O'$ will then be divided up by the trains, so that

$$L=(n-1)d+2q, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where n = the maximum number of trains between O and O', *including* that at O, and $2q$ = the excess $E\,O'$.

Clearly, since $2q$ is less than d, n is the *maximum* number of trains there can be between O and O', and it may be any whole number, odd or even.

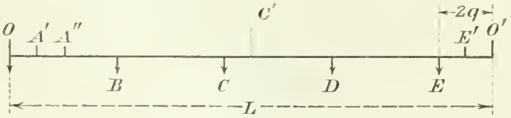

Fig. 1.

Now, consider a later instant, when A has moved to A' and C to C' and E to E'. Let $O\,A'=q$, then $E\,E'=q$ and $E'\,O'=q$, hence (1) still holds and, according as n is odd or even, there is a train at the central point between O and O' or at equal distances on either side of the central point. This may be called the "first symmetrical position." Consider a later instant, when A has moved to A'', where $O\,A''=2q$. E will then be at O', and just leaving the section $O\,O'$. The train behind A at distance d behind it, will now be a distance $(d-2q)$ behind O. Consequently, during the interval of time $(d-2q)/v$, there will be $(n-1)$ trains between $O\,O'$. It is evident, therefore, that there are two periods of time to consider:—

1. $2q/v$ hours during which time there are n trains between O and O'.
2. $(d-2q)/v$ hours during which time there are $(n-1)$ trains between O and O'.

During the latter period, there will be an instant when there is a symmetrical arrangement of trains—the *second symmetrical position*—when, according as n is odd or even, there will be one train on either side of the central point, at equal distances, $d/2$, from the centre; or, one train at the centre.

The formulæ for the pressure drop are different, according as n is odd or even. If n is odd, it is evident that the first symmetrical arrangement will give the maximum pressure drop, since the maximum number of trains (n) are being fed at the maximum average distance from the sub-stations. If n is even, it is not evident which will give the greater drop: (a) The first symmetrical arrangement with n trains; or, (b) the second symmetrical arrangement with $(n-1)$ trains, since in case (b) there is a train at the centre, while in (a) there is not. If n is even, both symmetrical positions should be calculated.

Variable Current and Diversity.

Let $O\,O'$ (Fig. 2) represent a section of line with a sub-station at either end. Suppose there are N trains, distributed as shown, between O and O'. N may or may not be equal to n, depending on whether n is an odd or even number.

Case I., N odd.—The central train must be assumed to take the maximum starting current $I_{\text{max.}}$. Let $I_{\text{av.}}$ = average current taken by each train.

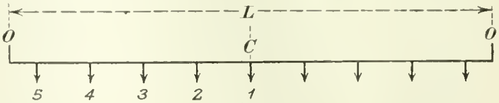

Fig. 2.

In the section 1—2, the current is $I_{\text{max}}/2$. Consider the section 4—5; the current passing in this section, i_4, at the instant when the central train takes maximum starting current is $<3{\cdot}5\ I_{\text{max.}}$, owing to diversity and the variation of the current per train.

Put $i_4=k_4\times 3{\cdot}5\times I_{\text{av}}$, where k_4 is a fraction appropriate to the section 4—5, the fourth section, measuring from C in the figure. k_4 is less than $(I_{\text{max.}}/I_{\text{av.}})$.

Generally, in the mth section from C

$$i_m=k_m(m-\tfrac{1}{2})I_{\text{av}}\ . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The exact value of k_m in terms of m is unknown, but it is known that

1. $k_m=I_{\text{max.}}/I_{\text{av.}}$, when $m=1$.
2. $k_m=1$, when $m=\infty$.
3. k_m continually diminishes as m increases.

Empirical Rule Suggested.—Assume k follows the hyperbolic law in respect of m, i.e., put

$$\left.\begin{aligned} k_m&=\left(1+\frac{a}{m}\right), \\ \text{where}\qquad a&=\left(\frac{I_{\text{max.}}-I_{\text{av.}}}{I_{\text{av.}}}\right) \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

($a=0$ corresponds to the case of constant and equal currents to each train.) This rule has the merit of being definite and reasonable, and it lends itself to concise treatment. If δE stands for the drop of pressure between C and O or O', and r for the track resistance per mile (inclusive of positive *and* negative circuit),

$$\delta E=\frac{I_{\text{av.}}\times r}{2}\left[d\left(k_1+3k_2+5k_3+\ldots\text{to }\frac{N-1}{2}\text{ terms}\right)+Nq'k_{\frac{N+1}{2}}\right]$$

where q' is given by

$$L=(N-1)d+2q'.$$

Substituting for k's by (3)

$$\delta E=\frac{I_{\text{av.}}\times r}{2}\left[d\left\{\left(1+3+5+\ldots\text{to }\frac{N-1}{2}\text{ terms}\right)\right.\right.$$
$$\left.\left.+a\left(1+\tfrac{1}{2}+\tfrac{1}{3}+\ldots\text{to }\frac{N-1}{2}\text{ terms}\right)\right\}+Nq'k_{\frac{N+1}{2}}\right],$$

i.e.,

$$\delta E=\frac{I_{\text{av.}}\times r}{2}\left[d\left\{\frac{(N-1)^2}{4}+a\left(\overline{N-1}-S_{\frac{N-1}{2}}\right)\right\}+Nq'k_{\frac{N+1}{2}}\right]\quad(4)$$

where $$S_{\frac{N-1}{2}}=\left(1+\tfrac{1}{2}+\tfrac{1}{3}+\ldots\text{to }\frac{N-1}{2}\text{ terms}\right).$$

$S_{\frac{N-1}{2}}$ is practically equal to $(\log_\epsilon N-0{\cdot}116)$, when N is large, while for any value of N above 3, the error is quite small. The constant 0·116 is $(\log_\epsilon 2-\gamma)$, where $\gamma=$ Euler's constant.

Equation (4) can therefore be written

$$\delta E=\frac{I_{\text{av.}}\times r}{2}\left[d\left\{\frac{(N-1)^2}{4}+a(\overline{N-1}-\log_\epsilon N+0{\cdot}116)\right\}\right.$$
$$\left.+Nq'k_{\frac{N+1}{2}}\right].\quad\ldots\ldots\quad(5)$$

Case II., N even.—In this case

$$\delta E=I_{\text{av.}}\times r\left[d\left\{k_1+2k_2+3k_3+\ldots\text{to }\left(\frac{N}{2}-1\right)\text{terms}\right\}+\frac{N}{2}q''k_{\frac{N}{2}}\right]$$

where q'' is as before given by

$$L=(N-1)d+2q''.$$

$$=I_{\text{av.}}\times r\left[d\left\{\left(1+2+3+\ldots\text{to}\left(\frac{N}{2}-1\right)\text{terms}\right)\right.\right.$$
$$\left.\left.+a\left(1+1+1+\ldots\text{to }\frac{N}{2}-1\text{ terms}\right)\right\}+\frac{N}{2}q''\cdot k_{\frac{N}{2}}\right]$$
$$=I_{\text{av.}}r\left[d\left\{\frac{N(N-2)}{8}+a\left(\frac{N-2}{2}\right)\right\}+\frac{N}{2}q''\cdot k_{\frac{N}{2}}\right].\quad.\quad(6)$$

Graphical Methods.—The formulæ (5) and (6) can be obtained approximately from a diagram of current against distance.

Case I., N Odd.—Suppose, first, that $q=0$, and let Fig. 3 represent this case.

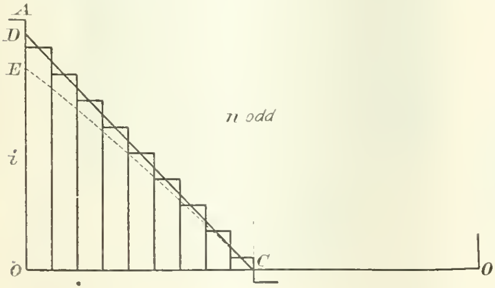

Fig. 3.

Instead of the line CD giving the average area of the I_{max}/distance diagram, the line CE does. The difference in the areas—DCE—represents the pressure drop saved by diversity. This area may be large or small compared to the area DCO, depending on the conditions of each case.

As before

$$i_m=\left(1+\frac{a}{m}\right)(m-\tfrac{1}{2})I_{\text{a}}\ldots\ldots\ldots\ldots\quad(7)$$

Let x be the distance of an element δx from C (Fig. 3).

When
$$x=\frac{d}{2},\quad i=\frac{I_{\text{av.}}}{2}(1+a),$$
$$x=\frac{3d}{2},\quad i=\frac{3I_{\text{av.}}}{2}\left(1+\frac{a}{2}\right),$$
$$x=\frac{pd}{2},\quad i=\frac{pI_{\text{av.}}}{2}\left(1+\frac{a}{\frac{p+1}{2}}\right),$$

the curve which passes through these points is

$$i=\frac{I_{\text{av}}}{d}\left(1+\frac{2a}{\frac{2x}{d}+1}\right)\cdot x.\quad\ldots\ldots\quad(8)$$

The area under this curve—CE—is the integral of (8) between $x=0$ and $x=\frac{L}{2}$, and the drop is given by

$$\delta E=\frac{rI_{\text{av.}}}{d}\int_0^{\frac{L}{2}}\left(x+\frac{2adx}{2x+d}\right)\delta x.^*$$
$$=\frac{rI_{\text{av.}}}{d}\left[\frac{L^2}{8}+\frac{ad}{2}\{L-d\log_\epsilon N\}\right],\quad\ldots\ldots\quad(9)$$

which is identical with (5), when $q'=0$ and the constant 0·116 is ignored, and $(N-1)d$ is put equal to L.

Case II., N Even.—Fig. 4 below illustrates this case.

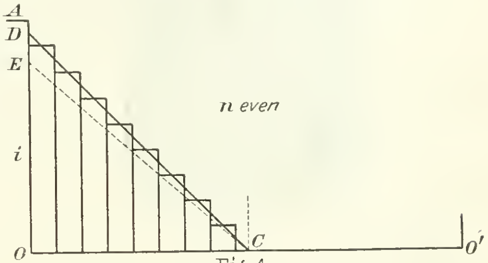

Fig. 4.

Here, $i=I_{\text{av}}\frac{x}{d}\left(1+\frac{ad}{x}\right)$, which is a straight line, and the integration must be taken between the limits $x=d/2$ and $x=L/2$, *i.e.*,

$$\delta E=r\frac{I_{\text{av}}}{d}\int_{\frac{d}{2}}^{\frac{L}{2}}x\left\{1+\frac{ad}{x}\right\}\delta x$$
$$=\frac{I_{\text{av.}}\times r}{d}\left[\frac{L^2-d^2}{8}+\frac{ad}{2}(L-d)\right].\quad\ldots\ldots\quad(10)$$

This equation is identical with (6), if $q''=0$ and N is eliminated by means of

$$L=(N-1)d.$$

Clearly, if q is not zero, terms have merely to be added to these equations to allow for the drop in the length q. These terms have been included in (5) and (6).

Pressure Regulation on Spur Lines.—In this case the line is fed from only one end. Assume a train at the far end, starting This train may be assumed to be the central train in a case of two sub-stations, where N is odd. The pressure drop may therefore be calculated from any of the formulæ already derived for this case, making allowance for the fact that the "central" train (*i.e.*, the one at the end) now receives the whole of its current from the one live end. This may be allowed for by adding the drop due to transmitting half the starting current per train from the live to the far end—*i.e.*, add $\frac{1}{2}I_{\text{max.}}rL'$, where L' is the length of the spur.

(*To be concluded.*)

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* δ is used in this and succeeding integrals instead of the usual d to avoid confusion with d—the distance between trains.

Large Outdoor Switches and Transformers.

By S. Q. HAYES and W. A. COATES.
Metropolitan Vickers Company

In 1914 the "Electrical World" published an analytical table of the 54 plants in the world working at 70,000 volts or over. Of these, 35 were located in North America, 10 in Europe and the remaining nine in other parts of the world. In 43 plants the switchgear was of American manufacture; in 10 plants German switchgear was used; and in five plants the apparatus was either Swiss or Swedish. Excellent service is, however, being obtained both with European and American gear. The chief difference between European and American practice in high-tension power transmission work is that in Europe outdoor transformers and switchgear for large capacity high-voltage work are practically unknown, while in America, for all pressures above 44,000 volts, outdoor transformers and switchgear are quite usual. During the last few years, probably 80 per cent. of the large capacity high-voltage transformers built in America, together with their switchgear, have been built for outdoor service.

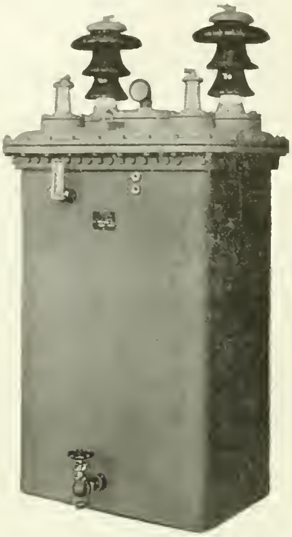

Fig. 1.—Early 40-k.v.a. Outdoor Transformer.

Until about 1907 small distributing transformers and arc lamps were about the only high voltage electrical apparatus exposed to the weather, but since that time, in America, there has been a growing tendency to increase the amount of outdoor high voltage apparatus and equipment. As a matter of historical interest, Fig. 1 shows a 40-k.v.a. 33,000-volt outdoor transformer supplied in the year 1908—practically the first of its kind. This transformer was provided with a plain case and the high-tension leads were taken out through porcelain bushings placed vertically in the top of it. There is very little difference between this design and those used to-day. A bank of 50,000/100,000 volt transformers of the tubular self-cooling type was installed in the year 1908, on the system of the Southern Power Company, to tie in between their 50,000-volt and their 100,000-volt systems. The whole gear was painted white to keep the apparatus as cool as possible during the summer. The tubular type of large capacity self-cooling transformer has now been superseded by the radiator type. Fig. 2 shows a 132,000-volt outdoor transformer, furnished in 1917. This transformer has a rating of 2,500 k.v.a. as a self-cooling unit, or 5,000 k.v.a. if run as a water-cooled unit, for 60-cycle service. It forms part of a bank used at the Washington (Pa.) sub-station of the West Penn Power Company, for tieing together their 132,000 and 27,000-volt systems. The water piping system is brought out through the side of the tank at such a point as to permit the complete drainage of the water-cooling coils in case the transformer is to be out of service for any considerable length of time during the winter.

Fig. 3 shows one of the earliest attempts at placing switchgear out of doors, installed by the Niagara, Lockport & Ontario Power Company in 1907. In this case only disconnecting switches and instrument current transformers were so placed, all being for 60,000 volts.

The first installation of oil circuit breakers for out-of-door service in a rigorous climate was built in the year 1909 for the Dominion Power & Transmission Company near Hamilton, Ontario. The bus-bars are arranged in grid-iron fashion so as to permit the interconnection of any of four incoming, and five outgoing, 44,000-volt lines. These being the first breakers installed for out-of-door service under very severe wintry conditions (−30° F. is not unusual), concrete sheds were then placed over them as a precaution to prevent the accumulation of snow. American engineers, however, now use outdoor breakers without any protection for the highest voltages and in any climate. The placing of large transformer units out of doors presents few unusual features, but there are certain problems in connection with circuit breakers which make their design differ somewhat from that needed for indoor service. Outdoor breakers must be operated without disturbing the weather proofing, and the position of the circuit breaker mechanism should be indicated by some device outside of the housing of the breaker. When a breaker operates under severe overload conditions a high internal pressure is set up that must be relieved, and provision must be made for getting rid of the gas formed during the heat of summer by the volatilisation of the oil. In winter time, if the breaker is located in a cold climate, steps must be taken to prevent the oil from solidifying. This is not necessary in connection with outdoor transformers, as usually the iron loss in the transformers generates sufficient heat to keep the transformer oil in a fluid condition. Heat is not generated in a circuit breaker during normal operation, and provision must be made for supplying the heat necessary to keep the oil sufficiently fluid, or a special grade of oil must be used that will remain fluid at low temperatures. As a rule two grades of switch oil are used for the summer months, an oil of high flash-point, in the autumn a very thin oil, the freezing-point of which is very low (say about −50° F.).

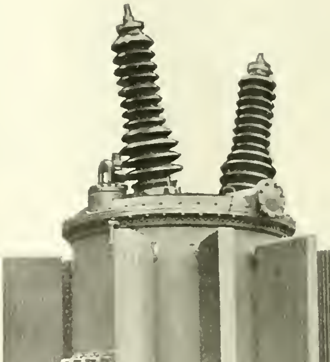

Fig. 2.—5,000-k.v.a. 132,000-volt Radiator Type Outdoor Transformer.

The oil circuit breakers used by the West Penn Power Company at their Windsor Power Station, have a guaranteed rupturing capacity of 1,000,000 k.v.a., or approximately 5,000 amperes per phase at 135,000 volts. These oil circuit breakers were guaranteed to operate with the external temperature between 0 F. and 120 F. Heating elements have been installed in the bottom of the circuit-breaker tanks in such a way as not to interfere with the action of the mechanism. Thus they are away from any high-tension parts and properly located for the heat distribution by convection current in the oil. The amount of power consumed by the heating elements is small, and can readily be taken from the station auxiliary or other low voltage circuits. It is possible to instal thermostatic devices to make the control of these heaters automatic.

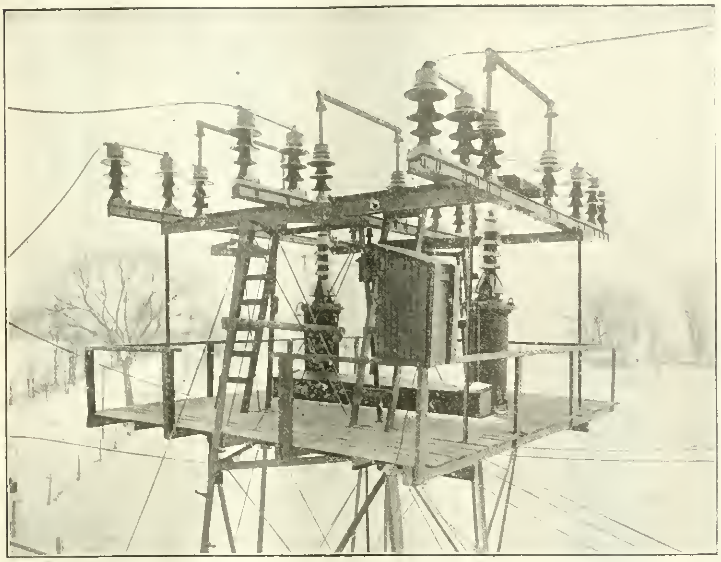

Fig. 3.—Outdoor Switching Station: Niagara, Lockport, and Ontario Power Company.

The mechanism of outdoor oil switches must be protected from the accumulation of snow and ice in sufficient quantity to interfere with the proper functioning of the breaker. Outdoor breakers are usually inspected less frequently than the indoor type and their mechanism must be of such rugged construction as to operate during long periods without any necessity for inspection and adjustment. The cases must be sufficiently tight to preclude the admission of moisture, and in certain localities they must be protected against dust and sand storms. Accordingly, the venting of the outdoor breakers is usually less ample than with indoor apparatus, so that the framing must have strength to withstand higher internal pressures than would be encountered in indoor equipments.

Fig. 4 shows a 400-ampere 37,500-volt 3-pole solenoid operated outdoor breaker with one tank removed to show the contacts. This breaker, built by the Westinghouse Company, is guaranteed to have a rupturing capacity of about 110,000 k.v.a. at 37,500 volts. Clamped pipe framework is now widely used for such structures in America. Mounting the circuit breaker up in this way makes it easy to drop the tanks and thus obtain ready access to the contacts for inspection and cleaning.

Breakers of large size may also involve elliptically shaped oil tanks made of steel plate, with lap welded seams and a cast steel top, dome shaped, to secure ample strength against explosion. This top is arranged for suspension from the supporting frame, which in this case is of rolled steel sections to give the necessary rigidity.

It is well known that the Westinghouse Company were the inventors and patentees of the condenser terminal. It was produced experimentally in 1906, and first practically applied in 1908. This terminal consists essentially of a tube or rod forming the conductor, and surrounded by a number of concentric condensers of predetermined capacity so arranged as to secure a practically uniform potential gradient from the inner one forming the line conductor to the outer one which is grounded to the case. Thus practically uniform the insulating material is not stressed beyond its dielectric strength. As the edges of the tinfoil used in the condensers extend to the edges of the cylinder of insulation immediately surrounding it, the difference of potential along the surface is definitely fixed and can readily be kept less than the puncture strength of the surrounding medium, usually either air or oil.

These condenser terminals (Fig. 5) are made by winding special coated paper under heavy pressure, and at a high temperature around the central tube that forms the main conductor. The various layers of paper 0·005 in. thick, are bonded together by resinous gum, and the temperature of manufacture is sufficiently high to melt this, making a perfect bond between adjacent layers. The tube, when completed, is practically one solid mass, capable of being machined and of taking a very high finish. At specified diameters metal foil is wound on without removing the tube from the winding machine. Twelve thicknesses, 0·060 in. of paper are used, between the foil layers.

The bushing, when first wound, has the form shown at A in Fig. 5. When this is removed from the special winding machine it is placed in an engine lathe and turned to its final form shown at B. In this final form the cylindrical portion is thoroughly banded with wire and forms the grounded portion of the bushing. The lower tapered end when in service is submerged in oil, while the upper tapered end is in the air. The length of the upper taper is approximately three times of the lower one, due to the increased surface insulation under oil. The bushing, when mounted in the tank cover, is provided with a suitable metal flange, and the tapered portion of the bushing which is to operate in air is provided with a cylindrical casing of Bakelite micarta, as shown at C.

The space inside of the micarta tube is filled with an insulating compound which remain solid at all operating temperatures. The micarta casing serves as a mechanical protection and minimises corona. The end of the casing is covered and sealed with a static shield, which further minimises corona and materially increases flash over voltage. The size of this shield varies with the service voltage from a diameter of 9 in. for the 88,000 to 120,000-volt bushings to a diameter of 72 in. for a 500,000-volt testing transformer. Without this device the electrostatic field between ground ring and conductor would be concentrated at the edge of the micarta where

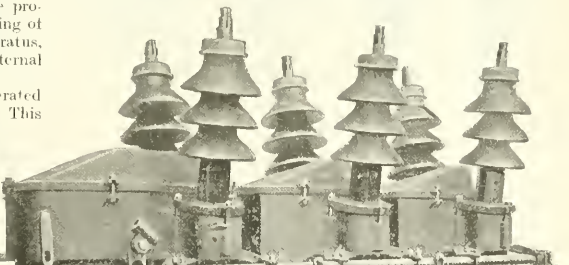

Fig. 4.—37,500-volt Solenoid operated Outdoor Breaker with one tank removed to show Contacts.

the conductor emerges and at the edges of each layer in the condensers.

Even without either dielectric filler or static shield the condenser terminal is remarkably free from corona. In test, as the voltage is raised, the flash-over figure is reached without any local brush discharges, but the addition of a properly designed static shield may quite feasibly increase the flash over voltage by nearly 100 per cent. These condenser bushings have a relatively large number of condensers, and approximately one condenser is used for each 4,000 volts at line voltage. The 66,000-volt bushings have 17 condensers, the 88,000-volt have 22, the 120,000-volt have 30 condensers, etc. For outdoor service a porcelain casing shown at D is employed. This consists of a series of short tubes carrying flaring petticoats. These are interlocked and cemented together so as to form a continuous tube. It is usual to test each bushing on two and one-half times the working voltage, and, in addition, when they are for use on outdoor service, a further test is made of twice the line voltage under a spray of water one-fifth of an inch per minute directed at 45 degrees from the vertical, the test lasting for one minute.

In Fig. 6 are shown the rounded contacts of a 135,000-volt oil circuit breaker. The main contact is made by spring plungers of the butt type, and, in addition, there is a "follower" contact which holds until the butts are well clear and then snaps out with a spring. The speed of rupture is greatly increased by this device. An interesting point of detail is that on both the oil-filled bushing and on the condenser bushing the metal of the mounting ring is carried down below the oil level when the bushing is on a switch or transformer. If this were not done, the surface electrostatic stress would be partly in air and partly through oil.

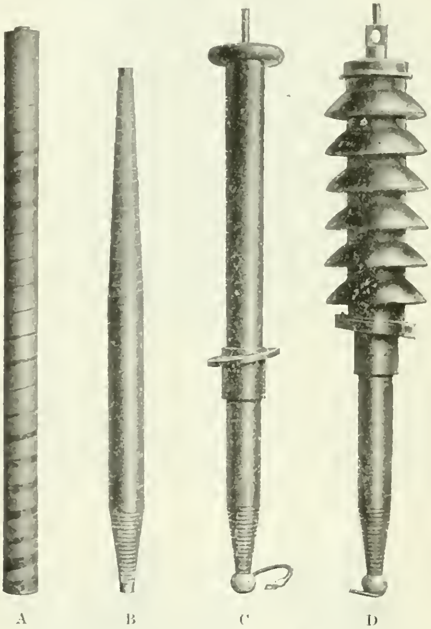

Fig. 5. Condenser Terminals.

On circuit breakers of small and moderate size where the weight of the oil tanks and oil is not prohibitive, the frame-mounting arrangement of circuit breaker is highly desirable, as it permits the ready removal of the oil tanks for the purpose of inspecting the contact details and the operating mechanism without disturbing the line connections. Breakers for high voltages and larger rupturing capacities are usually made platform mounting, owing to the difficulty of lowering the tank filled with oil. Experience has indicated the desirability of providing a structural frame or platform that will permit access to the bottom of the tank, allowing free air circulation, as this assists in keeping all parts free from rust and corrosion. In certain cases the tank bases are made with openings in the rims so that the bottom of the tanks can be painted with a long handled brush.

As an example of the floor mounting or platform-mounting type of breaker, Fig. 7, shows a 400-ampere, 115,000-volt, 3-pole outdoor type of oil circuit breaker, of which a large number were installed by the Inawashiro Hydro Electric Company in Japan. Identical breakers have been supplied to various power companies in America. This breaker has a guaranteed rupturing capacity of 375,000 k.v.a., or about 1,900 amperes per phase at 115,000 volts. Each pole is located in a separate elliptical steel tank with the bottom outside welded, and provided with a reinforcing rim. The dome-shaped top provides ample space for the operating mechanism, and a baffled vent is located in this top for discharging any gas that may have formed. The spacing of the poles of the breaker can be readily modified to suit the wiring of the installation, as the only mechanical connection between the adjacent poles is a simple pull rod running through a pipe connecting together the operating mechanism of the individual poles.

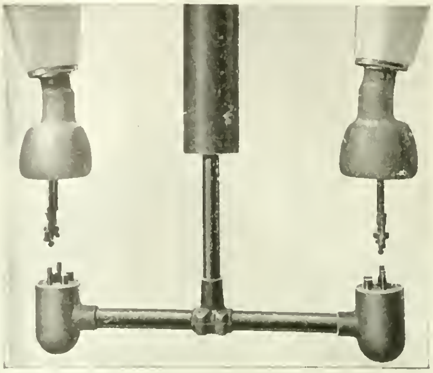

Fig. 6.—Contacts of 135,000-volt Oil Circuit Breaker.

At the beginning of this article stress was laid on the fact that America had led the way in the field of outdoor oil switch and transformer installations. Recently the first outdoor oil switch equipments have been installed in France, Italy, and Spain on the Lac d'Oo 120,000-volt, Pescara 80,000-volt, and Cataluna schemes respectively. Other installations on 120,000, 70,000, and 60,000 volts are now in course of building, and it is safe to say that in the future no really large high-voltage switchgear plant will be installed in these countries without full and serious consideration being given to the possibilities of outdoor gear.

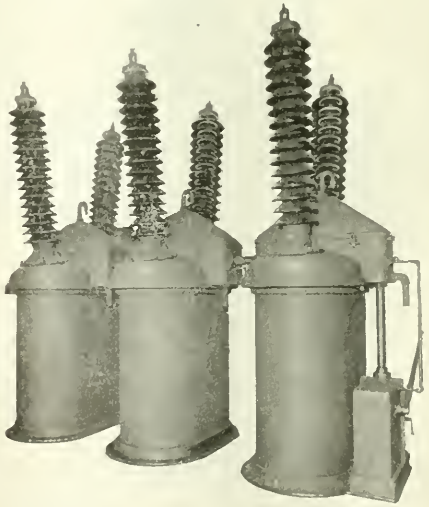

Fig. 7.—115,000-volt 3-pole Outdoor Type Oil Switch. Rupturing Capacity 375,000 k.v.a.

The Protection of Alternating-Current Systems Without the Use of Special Conductors.[*][†]

By Major KENELM EDGCUMBE, R.E.(T.).

Introductory.

The disconnection of faulty plant or feeders, whilst at the same time maintaining continuity of supply, is at the moment one of the most pressing of the problems which confront the power station engineer and is becoming one of ever increasing difficulty as networks are extended, larger power units are installed and adjoining systems are linked up. The methods adopted must be such as can readily be applied to the various sections of an existing system as well as to any future extensions. The author believes the four cardinal points of a protective system to be :—(1) The maintenance of continuity of supply, (2) simplicity of the apparatus involved, (3) adaptability to existing gear with minimum alterations, and flexibility as regards future extensions, (4) economy in its true sense, having regard to the capital sunk in cables, &c.

Advantages of an Earthed Neutral.

Intimately connected with the problem of the isolation of faults is the question of earthing the neutral point. Whatever advantages may, at one time, have been claimed for the insulated neutral, it is now fully recognised that the advantages are all in favour of earthing.

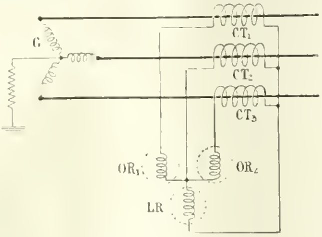

Fig. 1.—Leakage and Overload Protection of Feeder.

An obvious objection to leakage protection when used by itself is that, should the fault either start as, or immediately develop into, a short-circuit between phases, there will be no out-of-balance current and, consequently, the leakage relay will not act. To obviate this, overload relays (OR$_1$) and (OR$_2$) can be included in two of the branches, as shown in Fig. 1, and under these circumstances one at least of the relays will act under all possible fault conditions, whether of short-circuits or earths. Since one of the principal advantages of such an arrangement lies in the smaller current with which the circuit breakers are called upon to deal, it is obviously essential to limit the earth current, and this can best be done by an earthing resistance connected between the generator neutral and "earth" (ER in Fig. 1).

The Protection of Independent Feeders.

In cases where the feeder runs to a substation from which other feeders radiate, only those breakers which control the faulty feeder must operate. Such discriminating action can be obtained by giving the various relays different time-lags. Such graded time-lags, when applied to overload relays, have a further very important advantage. It is well known that although the short-circuit current of a modern alternator is comparatively small, probably not more than twice to three times its full-load current, yet the momentary current flowing into a short-circuit may be 10 times as great as the steady value. Now in the case of a dead-short-circuit occurring close to the generating station if the breaker were to open instantly it would have to break a current nearly seven times as heavy as if it opened after 1¼ seconds. The further from the generating station a fault occurs the more the short-circuit current will be reduced by the impedance of the intervening feeders, so that shorter time-lags can safely be given to the relays. The question still remains as to whether the time-lags should be fixed[‡] or inverse, *i.e.*, independent of the magnitude of the fault current or an inverse function of it. It may be stated without fear of contradiction, that more interruptions of supply are caused by opening circuits prematurely than by leaving a fault on the system for too long a time. An interval of 2 seconds should probably be regarded, however, as the upper limit, and for sub-stations containing synchronous machinery this figure must be considerably reduced. If fixed time-lags are employed they must be made sufficiently short to deal adequately with short-circuits and, as a result, cables may be disconnected unnecessarily on the occurrence of small momentary overloads. For these reasons inverse time-lags are in every way to be preferred.

Relays should invariably be scaled both in overload and short-circuit time-lags. The induction relay is much to be preferred to the fuse-shunted solenoid pattern. With leakage relays, likewise, there is nothing to be gained by the adoption of a fixed time-lag, although the objections to it may be less strong than in the case of overload relays. The combination of leakage and overload relays has the important advantage that it is sufficient in itself to deal with faults at any and every point of the system, including the sub-station busbars, whereas many other methods such as the Merz-Price or the "split conductor," act in water-tight compartments in that they only control individual sections of the feeders and afford no protection whatever to the sub-station busbars. For this reason, when balanced protection is adopted, overload protection by means of fuses is usually advocated in addition, whereby simplicity is sacrificed and the instantaneous action which is generally put forward as a great feature of such systems is entirely lost.

The current settings of the relays will necessarily depend upon the capacity of the feeder, but whilst the minimum time necessary for the operation of the breakers should form the basis in arriving at the time intervals between the settings of the relays, a considerable reduction is nearly always possible owing to the discriminating effect of the current settings. As an example of this, a large railway system near London may be cited as having in one case five sets of induction-type overload relays in series, each operating at 50 per cent. above the full load of its feeder and set with an interval of only 1/10 second between their short-circuit time lags. Several faults have occurred at different points and have, in each case, been cleared without any disturbance to the system.

The Protection of Parallel Feeders.

A very usual arrangement of protecting parallel feeders is to install reverse relays at the sub-station ends of each feeder, on the assumption that the normal flow of power being from left to right, a flow from right to left necessarily implies a fault and should cause the appropriate relay to operate. An objection to this arrangement is that if the cables are heavily loaded at the time, a high-resistance fault may not cause the current to reverse at all so that the feeder will not be isolated. This difficulty can be overcome by the use of differential reverse relays, the current connections for which are shown in Fig. 2. CT$_1$ and CT$_2$ are two current transformers, cross-connected in such a way that a flow of current in the direction indicated by the arrows merely causes a circulation of current in the secondaries, and none flows through the relays RR$_1$ and RR$_2$ which are connected in series between equipotential points. On the occurrence of a fault, the currents in the two feeders are no longer equal and the difference-current flows through the reverse relays which are so arranged that one or the other operates, according to the direction of the current through them, and thus isolates the faulty feeder alone.

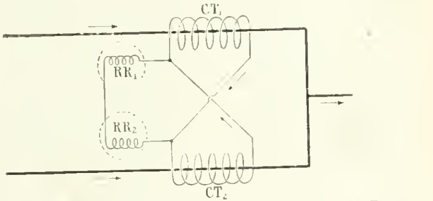

Fig. 2.—Differential reverse relay Protection of a Pair of Parallel Feeders. (Only one phase and shown pressure connections omitted, for the sake of clearness.)

In the case of four or six parallel feeders they can be very simply arranged in pairs and with three such feeders the connections shown in Fig. 3 are applicable. Normally, all three carry approximately equal currents. In the event of any variation in the current in one of them, due to a fault, the difference-current flows through the corresponding relay and causes it to operate. As soon as this has occurred, and the faulty feeder has been disconnected, the current transformer and its relay merely represent useless impedance and reduce the sensitiveness of the remaining two relays. To obviate this a switch (S) should be provided which is automatically closed by the circuit breaker as it comes out, so that the current transformer is short circuited and the connections of Fig. 3 become equivalent to those of Fig. 2. At their outgoing ends, parallel feeders present much the same problem as a single feeder and may be similarly dealt with by means of combined overload and leakage trips, a group of relays as shown in Fig. 4 being applied to each feeder; or to prevent the sound feeder coming out instead of the faulty one, or fault current flowing into the sound feeders it is preferable to install differential reverse relays (Figs. 2 or 3) at the outgoing end as well as at the other. To prevent the sound feeder being isolated by the fault current the circuit breaker on each feeder should be fitted with an auxiliary contact which, in coming out, renders inoperative the relay on the opposite feeder. Apart from the fact that a reversal will cause its relay to act, the sound feeder is left without protection. To remedy this, overload relays may be added or the reverse relays can be rendered operative on a heavy forward current. If there are a number of parallel feeders in series, perfect discrimination is afforded by the arrangement described.

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[*] Abstract of a Paper read before the Institution of Electrical Engineers.

[†] The expression "protection," used in this sense, is well established, but in the author's opinion is somewhat of a misnomer. To speak of the "isolation of faults" would be better, since no circuit breaker "protects" a system against the occurrence of a fault. Its functions are limited to the isolation of the faulty section.

[‡] Or "definite," as they are called in America.

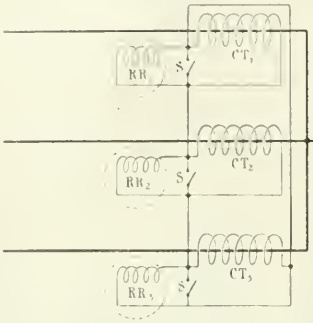

Fig. 3. Differential Reverse Relay Protection of Three Parallel Feeders. (Only one phase shown and pressure connections omitted, for the sake of clearness.)

Requirements of a Reverse Relay.

It is of fundamental importance in the case of all protective systems involving reverse relays that the latter should operate with certainty even if the voltage of the system is pulled down to a small fraction of the normal. Relays are often set to trip with twice the full load current. To set them to act at such a low current is to court disaster, seeing that momentary reversals amounting to considerably more than 10 per cent. are bound to occur in practice, and for a circuit breaker to be tripped under such conditions is fatal. The only true solution, therefore, is to render the reverse relays as far as possible independent of a fall in voltage. Compensated differential reverse relays worked successfully on an extensive overhead system working at 100,000 volts which suffered from a series of shut-downs due to lightning and on which various systems of protection were tried and found quite ineffective.

Protection of Interconnectors and Ring Mains.

In these the normal flow of power may be in either direction, according to the distribution of the load at the moment. Fig. 4 shows such an arrangement, * which is responsive not only to overloads but also to leakage. In many cases the interconnectors forming the ring may be run in parallel and, in that case, a simple solution is afforded by the use of the differential reverse relays† shown in Figs. 2 or 3, as the case may be. A moderate time-lag of, say, ½ second will be found sufficient for all the relays since they are inoperative except against a fault in the particular pair of feeders which they control. At the generating station ends pure overload relays may be substituted for the differential reverse relays, since the flow of power is always in the same direction at these points, but it is usually more convenient to employ the same type of relay throughout, and exact discrimination is thereby more easily obtained.

It is important to distinguish between the functions of the relays at the respective ends of the parallel feeders. In the case of an interconnector or a ring main for instance the flow of energy may be in either direction, so that the relays at each end must be able to exercise one or other function according to the direction of flow. The only relays capable of this are those in which the sense of direction is given by a pressure winding. Relays having current discrimination only can be arranged to cut out *either* the more or the less heavily loaded feeder, but are incapable of performing both functions and are therefore useless for the protection of interconnectors or rings.

Protection of Generators and Transformers.

The reverse relay, compensated for voltage, forms one of the simplest and most direct methods of generator protection. The criterion of whether a generator should be removed from the busbars or not is presumably whether it is still in a position to supply power to the system or is actually taking power from it. Most isolating devices are only sensitive to an earth or a fault between phases and will not operate on the occurrence of a short-circuit between turns, or of a mechanical breakdown, or a mistake in paralleling. A reverse relay, on the other hand, will operate under all fault conditions. The fear is sometimes expressed that a heavy cross-current, whither due to bad paralleling, hunting of the generators, or of a fault elsewhere on the system, may bring out the generator breaker if controlled by reverse relays. Experience shows, however, that with reasonable current settings and a time-lag of a fraction of a second such fears are quite groundless. It may be pointed out that although the circulating current between the machines is often considerable, it is very much out of phase with the voltage and consequently has little tendency to operate the relays. On the other hand, if an actual mistake is made in paralleling and a generator is connected to the bars either when dead or when out of phase, the relay will act and prevent damage.

In a number of stations, generators are still protected by means of overload relays. It is then a matter of pure chance whether the faulty or a sound generator is removed from the bars. If only two machines are running at the time it will certainly be the sound one; if there are a number running there may be some hope of its being the faulty one which is cut off. Since existing current and potential transformers can in almost all cases be used, the change from overload to reverse relay control should most certainly be made.

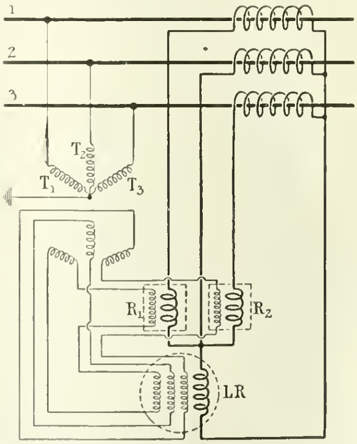

Fig. 4.—Feeder Protection by Combined Overload and Leakage Reverse Relays.

It is important, whatever system of protection is employed, that the field of the faulty generator should be broken immediately the machine has been taken off the bars, otherwise the stator will inevitably be destroyed owing to the heavy fault current. In fact, in the author's opinion it is of even greater importance that the field should be promptly opened than that the generator should be removed from the bars, and the simplicity of having the trip coils of the field and main circuit breakers in series across the relay contacts has much to recommend it.

(*To be concluded.*)

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* See also Patent No. 8569 of 1912.

† Since in the case of interconnectors the flow of power may be in either direction, even under healthy conditions, relays used in this way might be more correctly described as "directional relays"—following the American practice—rather than as "reverse relays."

Heating and Cooking Notes.

The Use of Domestic Table Appliances.

The value of electric irons, kettles, toasters, &c., as sales missionaries for larger apparatus is not by any means realised, as it should be firstly by supply authorities, and secondly by contractors. Perhaps no other piece of electric heating apparatus has proved itself to be so satisfactory in use as the electric iron, yet hundreds of consumers have been allowed to become annoyed by broken flex when a little advice given when the iron was sold would have obviated future trouble.

Handy as it may be to sell an iron for use direct off a lamp-holder, in many cases it would be far better to recommend the use of a plug, or an extra pendant. The plug is undoubtedly the best way out of the difficulty, but in these days of high labour charges the cost may prove a deterrent and prevent the sale of the iron. By running an extra flex out of the ceiling rose in the kitchen and supporting it from a ceiling hook placed some 6 in. away from the rose will provide a convenient means of using the iron at night when the ordinary pendant is required for lighting purposes. Another method of overcoming this difficulty is by means of the special adapter illustrated in Fig. 1. It can be inserted into any lamp-holder in place of the lamp, and provides two further lamp-holders, wired in parallel. A switch is also mounted in the device so that the lamp can be switched off if the apparatus is used in connection with ironing, &c., in the day time. The cost is but a few shillings, and the risk of breakage in the removal of lamps is obviated.

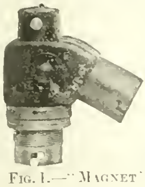


Fig. 1.—"Magnet" Heat Adapter.

The only disadvantage is that the weight of the heater adapter and the swaying of the flex when ironing causes wear at the socket holes of the lamp-holder with the possibility of causing sparking, resulting in local heating and loss of temper in the plunger springs. The use of a spring support for the flex, as illustrated in Fig. 2, will, however, overcome this difficulty. The illustration shows the spring support in use with an ordinary pendant and without the adapter, but the method can be applied equally well when the heater adapter is used.

The spring takes up the tugs and pulls on the flex when ironing is being done, and consequently relieves the lamp-holder from such strains and prevents sparking and local heating taking place in the lamp-holder.

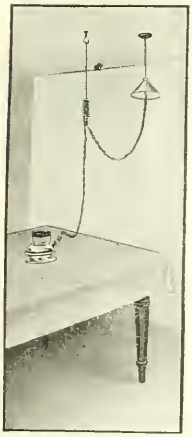


Fig. 2.—Spring Support for Iron Flex, Suspended on Cord From Ceiling Hook.

Consumers should always be advised that the use of too short a flex invariably leads to breakage and trouble, whilst a very long flex is equally troublesome, because it is liable to get trodden on and entangled with neighbouring objects. Iron connecters as designed by several makers prevent a mechanical strain occurring at the terminal sockets when the flex is pulled taut. These should always be recommended to customers in preference to others, where on the flex being pulled the ends come out of terminal sockets, usually causing a "short." The use of the spring support shown in Fig. 2 will prevent such strain occurring on the pendant and obviate risk of damage there.

When selling an electric iron it is always well to find out for what use it is intended. A 3 lb. lace iron will do for lace or silk blouses, but it will not iron damped sheets or other heavy articles. The average ordinary household flat iron weighs from 5 to 6 lb., and therefore for general use it is unwise to recommend anything lighter than a 5 lb. electric iron. Small and elementary as these points are, they have a great effect on the ultimate success in the development of the sale of electric irons.

Purchasers of self-contained kettles, water boilers, milk heaters, &c., should not only be warned against switching on the current when the apparatus is empty, but should also be advised either immediately to pour some cold water into the kettle after it has been used or never quite to empty it. The reason is that there is always residual heat in the element after the current is switched off, and if the kettle has been in use for some time the residual heat may be sufficient to melt the solder or otherwise damage the kettle.

There is now a type of immersion heater, which can be switched on when not immersed, but previously it was necessary to warn users against doing this and still is necessary except in the case of the one particular type.

Other devices which have appealed to the public are toasters, coffee percolators, kettles and the like, particularly so because they were well finished and attractive in appearance. They could be used on the dinner and tea table without fear of damaging the table linen and without spoiling the appearance of a well-laid table. The disadvantage of their use in this connection was that of the flex. The table is not usually placed against a wall, consequently a wall plug cannot be conveniently used. To make a flex connection with a lamp pendant above the table is not an attractive method so far as appearance goes. The use of a floor plug necessitates cutting a hole in what may be a valuable carpet, and further such a plug is always liable to damage by persons walking in the room. Where the cost of wiring plug points is not prohibitive undoubtedly the best method is to employ a small side table or buffet board placed against the wall of the dining room. A definite and effective plug connection can then be obtained, and all flexes are clear of the dining table and out of the way. Such a method is illustrated in Fig. 3. A Jacobean Buffet Board with low rail back is shown placed against the wall, and just above the rail is mounted a three plug board with three controlling switches. This allows for the use of kettle, toaster, coffee percolator, chafing dish, or plate and dish warmers. Service from the buffet board to the dining table is easy and convenient. Where the dining room furniture does not provide a buffet board a small table or dinner wagon will serve the purpose equally well.

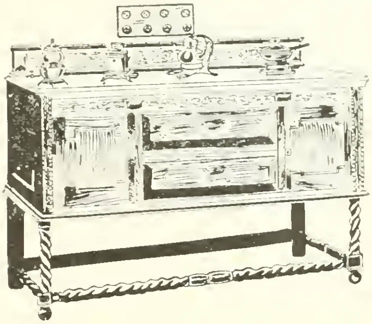


Fig. 3.—The Electric Buffet Board.

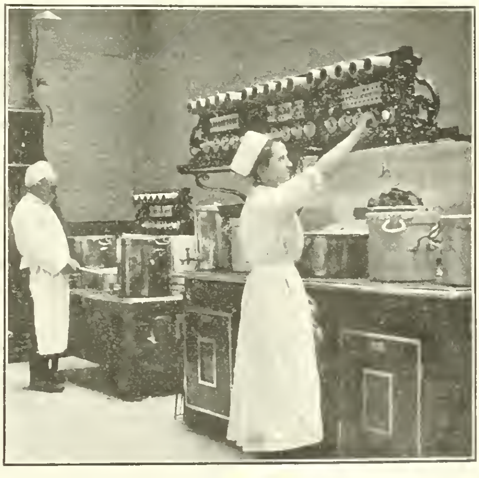


Fig. 4.—The View of Kitchen at Bannerman Mills.

In the drawing room for afternoon tea purposes the same idea can be carried out by providing sunk wall plugs and switches mounted at a convenient height on the wall to allow for the kettle and toaster to be placed on a small table. Similarly in the bedroom a bedside table will take a kettle or milk boiler.

In electricity applied to the purpose of heating and cooking we have the most convenient form of heat agent it is possible to obtain. It, therefore, behoves us to make every possible use of these advantages, and to so install the apparatus that maximum benefit is obtained by the consumer.

Electric Cooking and the Textile Industry.

Employers are now finding it necessary for everybody's advantage to adopt some system of welfare work in their factories. One of the most satisfactory ways in which this can be done is to establish a canteen, so that the workers can obtain an adequate and well-cooked meal in the middle of the day. It is obvious for this purpose electric cooking has definite advantages, and it is now some years ago since the first of these installations was successfully put to work. Among the recent recruits to the use of electricity in this form may be mentioned Messrs. Henry Bannerman & Sons, the well-known Manchester textile firm, whose head, Sir Charles Macara, takes a great interest in the welfare of those employed under him.

The first electrical cooking apparatus employed by this firm was installed at the Brunswick Mill, Ancoats, about 18 months ago by the Carron Company, and since then similar kitchens have been fitted up in the warehouse at York-street, in Manchester, at North End and River Meadow Mill, Stalybridge, and at the Old Hall Mill, Dukinfield. Fig. 4 shows the type of apparatus used, which includes a three-oven range, boiling table, a griller and a hot cupboard, the latter being so arranged that it forms a counter over which the portions are served. We understand that a very tasteful and varied menu is provided, and arrangements are made whereby workers obtain their meals by relays, so that the running of the machinery is not interfered with. The organisation of this scheme has been in the hands of Miss Alice Macara, who states that "our experience of electrical cooking is very satisfactory, especially as regards the cooking of the food, cleanliness and the health of the staff."

British Industries Fair—Birmingham and Crystal Palace Sections.

Alongside the Railway Station at Castle Bromwich, 5½ miles out from Birmingham on the line from Birmingham to Derby, a small army of workmen are busy making great preparations in three large buildings which will constitute the Birmingham Section of the British Industries Fair, which is being organised by the Board of Trade, the opening date of which is Monday next, February 23rd.

The Fair is being organised solely in the interests of British commerce, the aim being to advance British trading interests. It is intended to make it an annual event. There will be, it is anticipated, 100,000 prospective buyers who will receive invitations to visit the exhibition, and arrangements have been made to afford them every assistance in attaining the object of their visit. Particulars of steamship service from all parts of the world, time tables relating to English railways, conversion tables, both in money, weights and measures, particulars of hotel and other lodging accommodation in the City, and surrounding districts, and other information required, will be supplied on application. A staff of competent interpreters will be available to facilitate the transaction of foreign business.

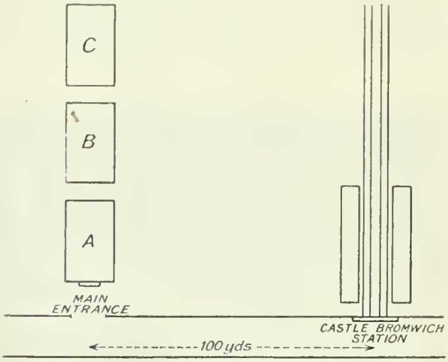
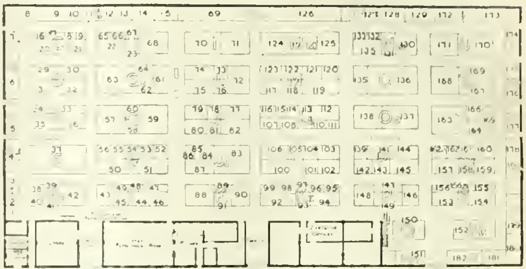


Fig. 1.—Rough Plan of British Industries Fair, Birmingham Section.

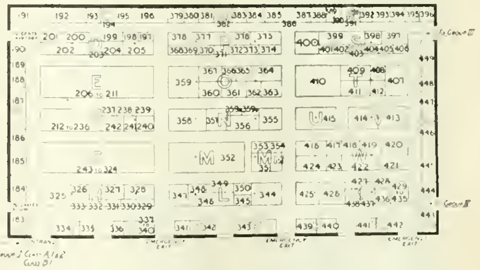
We give in Figs. 1 and 2 a general layout of the three buildings A, B and C. The main entrance in Building A is not a minute's walk from the station, and it will be noticed that the stands are uniformly arranged, straight aisles dividing the rows. Visitors will appreciate this on account of the ease with which they will be able to view the whole Exhibition without feeling that they are in a maze.

Most of the exhibits appertaining to the electrical trade are in Building A, the exhibits in Buildings B and C being mostly of the heavy engineering class, and appertaining to non-electrical industries.

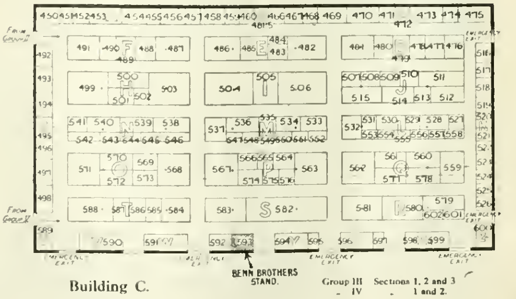
There will be approximately 750 exhibitors, some of whom will exhibit on their own premises, and for the convenience of our readers



Building A. Group I. Class A. Sections 1 and 2
" B. " 1



Building B. Group I. Class B. Section 2.
" II. Sections 1, 2, 3, 4, 5.
" V. " 2 and 3.



Building C. Group III Sections 1, 2 and 3
" IV " 1 and 2.

Fig. 2.—Plans of Buildings Showing Arrangements of Stands.

we give below a list of the firms and their stand numbers, who are exhibiting productions directly interesting to the electrical industry.

Firm.	Address.	Stand.	Building.
Alloy Welding Processes, Ltd.	London	407	B.
Attwater & Sons	Preston	344	B.
Austin Motor Co., Ltd.	Birmingham	69	A.
Avery, W. & T., Ltd.	Birmingham	352	B.
Bastian Electric Heater Co., Ltd.	London	71A	A.
Benjamin Electric Ltd.	London	42	A.
Benn Bros., Ltd.	London	593	C.
Berry's Electric, Ltd.	Birmingham	102	A.
Best & Lloyd	Birmingham	51 & 477	A. & C.
Birmingham Guild, Ltd.	Birmingham	Own Premises	43A.
Birmingham Private Telephone (New System Co., Ltd.)	Birmingham	151	A.
British Ever Ready Co., Ltd.	London	525	C.
British Lighting & Ignition Co.	Birmingham	546	C.
Bulpitt & Sons, Ltd.	Birmingham	4, 135 & 496	A. & C.
Bush Terminal Co., Ltd.	London	Town Hall Ser. Sec.	
Canning, W., & Co.	Birmingham	485	C.
Chloride Electric Storage Co.	Manchester	15	A.
Crabtree & Co., Ltd.	Walsall	Own Premises	50A.
Frederick Crane Chemical Co.	Birmingham	369	B.
Daisy Vacuum Cleaner Co., Ltd.	Birmingham	150 & 152	A.
Damard Lacquer Co., Ltd.	Birmingham	565	C.
Donovan & Co.	Birmingham	20	A.
Edison Swan Electric Co., Ltd.	Middlesex	35	A.
Electric Appliances Co., Ltd.	London	157	A.
Etna Lighting & Heating Co., Ltd.	Birmingham, London & Manchester	38	A.
Evered & Co., Ltd.	Smethwick	272	B.
General Electric Co., Ltd.	Birmingham & London	Own Premises 24	
Gledhill Brook Time Recorders, Ltd.	Huddersfield	364	B.
Harrison & Co., Ltd.	Birmingham	284	B.
Heckford, A. E.	Birmingham	280	B.
Hughes Johnsons Stampings, Ltd.	Langley Green	225	B.
Industrial Appliances, Ltd.	Westminster, S.W.	503	C.
Ingram & Kemp, Ltd.	Birmingham	40	A.
Jackson Electric Stove Co., Ltd.	London	63	A.
Joyner, Charles & Co., Ltd.	Birmingham	39	A.
Kynoch Ltd.	Birmingham	293 & 508	B. & C.
Lee Howl & Co., Ltd.	Tipton	131	A.
Lighting Ltd.	Manchester	60	A.
Litholite Ltd.	London	17	A.
London Elec. Wire Co., & Smiths, Ltd.	London	237	B.
Lucas Electrical Co., Ltd.	Birmingham	530	C.
Lucas, Joseph, Ltd.	Birmingham	542	C.
McKechnie Bros., Ltd.	Birmingham	326	B.
Midland Electric Manfg. Co., Ltd.	Birmingham	56	A.
Midland Fan Co.	Birmingham	589	C.
Monometer Manfg. Co., Ltd.	Birmingham	72	A.
Osler, F. & Co., Ltd.	Birmingham	57	A.
Premier Electric Heaters, Ltd.	Birmingham	1	A.
Relay Automatic Telephone Co., Ltd.	London	383	B.
Robinson & Hands Elec. Co., Ltd.	Birmingham	53	A.
Sankey, Jos., & Sons, Ltd.	Bilston	172	A.
Sigma Instrument Co.	Stratford/Avon.	404	B.
Siemens Bros. Dynamo Works, Ltd.	London	22	A.
Sperryn & Co., Ltd.	Birmingham	38	A.
Sun Electric Co., Ltd.	London	3	A.
Terry, Herbert & Sons, Ltd.	Redditch	536	C.
Thursfield, C. J., & Co., Ltd.	Birmingham	46	A.
Tok Manufacturing Co., Ltd.	London	62	A.
Tucker, J. H., & Co., Ltd.	Birmingham	44	A.
Venner Time Switches, Ltd.	London	64	A.
Vickers Ltd.	London	206 & 211	B.
Ward & Goldstone	Manchester	43	A.
Western Electric Co., Ltd. (Representing British Electric Vehicles, Ltd.)	Birmingham	511	C.
Wiggin, Henry, & Co., Ltd.	Birmingham	185 & 323	B.
Wineberg & Co.	Birmingham	474	C.

The Exhibition will be open from 10 a.m. until 6 p.m. on each week day up to and including March 5. There will be an half-hourly train service from New Street Station, Birmingham, which will make the Fair easily accessible from the City, and in addition to this there is a motor 'bus service, which starts from the Bull Ring, Birmingham. Visitors will be well catered for as regards refreshments, they will be able to obtain mid-day lunch and late dinners if desired in the refreshment rooms situated in Building A.

We are sorry to say that the general lighting of the buildings is by Tilley high-pressure gas lamps, but the stands themselves are electrically lighted, three 48 k.w. lighting sets (by the National Gas Engineering Company) being situated between Buildings B and C. In addition to this the lighting of several stands in Building A is being supplied from three lighting sets by the Austin Motor Company in conjunction with the Chloride Electrical Storage Company from their Stands Nos. 69 and 15. The buildings will be comfortably warmed by steam pipe heating arrangements, so it will be seen that the visiting public are generally being well catered for

The grouping and classification of the exhibits which are being shown in Birmingham are as follows :—

GROUP I.

Class A.

Section 1.—Chandeliers, candelabra, gas fittings, electric light fittings and accessories, table lamps, hall lamps, standard lamps, &c. (excluding electric pocket lamps), including the appliances and apparatus and glassware appurtenant thereto.

Section 2. Cooking and heating stoves of all kinds ; grates, ranges, builders' ironmongery, architectural and ornamental metal-work, including gates, fencing, &c. ; military, naval, cabinet, plumbers, domestic and other brassfoundry ; sanitary apparatus and appliances of all kinds ; bar-fittings and shop window fittings (including wooden fittings), cardboard boxes, as used in all trades represented in this Section of the Fair.

Class B.

Section 1. Furniture of metal for house, shop, garden and camp, including bedsteads ; household ironmongery ; hollow-ware (including aluminium and enamel-ware) ; copper goods and bronzes (excluding fancy goods, such as spun metal goods, flower pots, ash trays, metal photograph frames and small bronze figures).

Section 2.—General hardware ; safes, locks, keys, cash boxes, deed boxes, tin and iron trunks, wire goods, &c. ; brass and copper and iron and steel tubes, pipes and fittings, cold rolled brass and copper, ingots, strip sheets, and circles, brass, copper, and phosphor bronze wire and rod, brazed brass tubes.

GROUP II.

Section 1.—Tools : Carpenters' and joiners', engineers', and other industrial tools, and edge tools generally.

Section 2. Nautical scientific instruments and apparatus, as sold by marine stores and ships' chandlers.

Section 3.—Machinery belting of leather, rubber, &c. ; industrial rubber goods, such as engineering factory, and household requisites ; grindery.

Section 4.—Scales, balances, and other weighing instruments, measuring instruments and appliances.

Section 5.—Small machine tools.

GROUP III.

Section 1.—Motor cycles, cycles, and motor car and cycle accessories, equipment and fittings.

Section 2.—Aeronautical motor appliances.

Section 3.—Perambulators, mail carts, push carts and push chairs (excluding toys).

GROUP IV.

Section 1.—Paints, colours, and varnishes, and painters' requisites.

Section 2.—Ropes and cables of steel or hemp ; string, twine, cord, &c.

GROUP V.

Section 1.—Guns, rifles, revolvers, &c.

Section 2.—Fishing rods, fishing tackle, &c.

Section 3.—Saddlery and harness and harness furniture.

For the general management and arrangement of the Exhibition, great credit is due to the General Manager, Mr. C. Stanley, and his staff, who have been conducting business from the Birmingham Chamber of Commerce.

In our next issue we shall give detailed descriptions of the various stands.

THE CRYSTAL PALACE.

In addition to the Fair at Birmingham, which, as will be gathered, is of great engineering interest, the Board of Trade are also organising a similar Fair at the Crystal Palace, which will be open from February 23 to March 5. This Fair will include a range of exhibits which, though of great interest to the trade of the country, are not particularly electrical or engineering in nature with the exception of stands devoted to scientific instruments. We shall deal with this branch of the Fair in a subsequent issue of THE ELECTRICIAN, and need only add that the other branches of trade represented include cutlery, silver and electroplate, jewellery, glassware, paper, printing, fancy goods, leather, brushes, photographic appliances and furniture. As at Birmingham, arrangements have been made for a special train service between the Crystal Palace and London Bridge, Holborn Viaduct and Victoria Stations. Interpreters will also be available for the use of visitors without any charge, and there will be an enquiry office at the Fair where visitors are invited to make applications for any information they may require.

National Conference of Manufacturers and Producers.

A National Conference of Manufacturers and Producers took place at Kingsway Hall, London, on Tuesday and Wednesday, Feb. 10 and 11, Mr. W. Peter Rylands, president of the Federation of British Industries, being in the chair. At this conference were present delegates from almost all bodies representing manufacturing and producing interests in this country, including the British Electrical Federation and the Provincial Electrical Supply Council of the United Kingdom.

In his opening address the Chairman said the ability of a nation to support its population depended upon the volume of its production. Many of the nations were now consuming more than they produced. Under normal working conditions economic equilibrium was easily obtainable, but the great financial upheaval resulting from the war aggravated by the enormous increase of credits had so disturbed this equilibrium that the usual laws had ceased to be effective. Debtor countries were so crippled that they could not export, and in Germany especially this had caused great inflation of prices and a depreciation of currency almost to zero. Germany, in order to pay an indemnity, must be in a position to produce. At present she could not export owing to lack of resources, and the United States could not export owing to excessive resources, a paradoxical conclusion which might prove of some assistance to Great Britain in finding a solution for her own troubles. We must see to it that we no longer consumed more than we produced, and the essential step towards that condition must be that Government borrowings must cease, and that production must be increased. It was a fallacy to protest against combinations under the impression that they inflated prices. Such combinations were very largely affected by public opinion, but when each manufacturer pursued an independent policy there was no such restraining effect.

A resolution proposed by Sir Arthur Steel-Maitland, M.P. (Federation of British Industries), called attention to the desirability of manufacturers setting aside some proportion of their output for export purposes, more particularly articles essential to home consumption. In speaking to this resolution Sir Arthur said a proposal had been made which was worth consideration, that a certain amount of work which could not be done in this country in consequence of the surplus of orders, might be done on commission on the Continent.

Mr. Harry Alcock, in supporting the resolution, said increased exportation did not materially influence the exchange question. The volume of material exported was at the present time more important than its value.

The Hon. R. H. Brand, C.M.G. (Federation of British Industries), moved a resolution urging the necessity for international action to relieve the present economic situation and for a recognition of the necessity for decreased consumption and increased production, and stating that assistance to countries needing it should take the form of the supply of essential raw materials.

Mr. A. M. Samuel, in seconding this resolution, said that if we sent goods to France we ought to receive in exchange more useful commodities than wine. He thought it was the constant propaganda of certain extreme sections in this and other countries which was forcing nations to find money for matters for which they could not afford to pay. Rich and poor ought both to set the example of cutting down the amenities of life, and so reducing the manufacture of paper money.

Sir William B. Peat (Federation of British Industries) moved a resolution calling upon the Government to cease borrowing forthwith, and to reduce taxation as soon as possible so as to diminish the tendency of capital and enterprise to seek development in foreign countries. The resolution also expressed opposition to a levy on capital, and welcomed the abolition of the Excess Profits Duty. Sir William Peat, in speaking to this resolution, pointed out that the working capital of every business had been provided in a large measure out of profits. If the manufacturers were not efficient and the men were not industrious the prospects of this country in world competition would be indeed poor. They needed absolute freedom from Government control in industry, as the Government had spent without considering the cost. What about the gigantic scheme for co-ordinating the supply of electricity, costing, perhaps, 60 millions in buying up undertakings, to give some inadequately estimated benefits in the remote future? The scheme would be run by bureaucratic control, and from every point of view would, in the light of experience, be an absolute failure. Why not leave the supply of electricity to those who founded the business and whose interest it was to make money out of the venture. If financial assistance were required let the Government give it with some measure of inspection. He hoped the compulsory clauses of the bill would be again ruled out and buried, so that they could not be unearthed.

Mr. Max Muspratt (Federation of British Industries and Association of British Chemical Manufacturers), proposed a resolution putting forward the opinion that the present high prices of manufactured goods were inevitable so long as the demand throughout the world remained greatly in excess of supply. To attempt to fix prices or restrict profits by Government action would not improve the situation, and the only remedy was for the Government to remove as far as possible all restrictions upon trade and to encourage the greatest possible development of production and distribution through normal channels. The conference recommended the Government to publish each month comparative statements showing the current prices of the chief commodities in the principal countries of the world. He said that the main cause of the increased cost of manufactured articles was the increase in wages. Nearly related to it, however, was social unrest, which also meant bad production. Maximum production was the sole means of reducing prices.

Sir Algernon F. Firth (Federation of British Industries and Association of British Chambers of Commerce), in seconding the resolution, said that profiteers were unduly blamed. They were the consequence and not the cause of the rise in prices.

Sir Adam Nimmo proposed a resolution deprecating any attempt to impose state management on any branch of industry. He said it was impossible to point to one successful case of state conduct of industry, and there was little doubt that under state management the cost of production would go up.

Mr. Arthur Pollen (British Commonwealth Union), in seconding the motion, did not think there had been Government control of trade during the war, but merely control of production. The Government had never had anything to do with the selling side, and therefore it was a fallacious argument to say that Government control during the war had proved the Government incapable of managing industry. This resolution was carried, with the addition of a clause which recognised the importance of educating the workers and of associating them with manufacturers in the responsibilities of the industry and welcoming any well thought out experiments to bring that end about.

Mr. Marshall Stevens, M.P. (Federation of British Industries), moved a resolution in which the conference viewed with concern the delay in re-establishing the efficient working of the railways, putting forward as its opinion that this was largely due to over-centralisation of control in the Ministry of Transport, and protesting against the action of the Government in fixing new increase in the railway rates upon an estimated deficit. A long letter from the Ministry of Transport was read upon this question of rates, and finally a resolution welcoming the decision of the Ministry of Transport to proceed immediately to the general revision of rates and giving an invitation to the trade organisations affected was passed.

A further resolution calling attention to the fact that since the introduction of the eight-hour shift the congestion of traffic on railways had increased with consequent reduction in output in this country, was also passed.

Lord Gainsford moved a resolution in which the conference viewed with alarm the chaotic condition into which the Government had allowed its coal policy to drift.

Mr. A. E. Berriman proposed a resolution urging manufacturers to give their practical assistance in the working of Mr. Fisher's Education Act.

Sir Robert Hadfield proposed a resolution of appreciation of the work of the Department of Scientific and Industrial Research.

The Ideal Home Exhibition at Olympia.

(*Concluded from p.* 171.)

A second visit to the Ideal Home Exhibition only serves to strengthen the impression which we gathered last week that this is one of the most successful displays that has been held. But like visiting a play on the first night, one does not always gather at the early stages of an exhibition the full extent of its possibilities; but now the stands are complete and the exhibitors are encouraged by their success to talk freely about what they are showing there is no doubt that a very distinct impression is being made on visitors. This applies not only to the stands where electrical apparatus is shown, but to the general range of the exhibits.

More About the "All-Electric" House.

We mentioned last week that one of the most striking features of the Exhibition was the "all-electric" house, which has been organised by the General Electric Company. We understand that the success of this house has been most striking, that the number visiting it is so large that long queues have to wait their turn for admission at most times of the day, and that as many as 650 visitors per hour have passed through it. The questions asked by those viewing what is to be seen there are intelligent and should form a good basis for designers and salesmen of electrical apparatus to build ideas upon in the future. In Fig. 4 we illustrate an external view of this house, but of course it is the interior which is of the greatest interest. To photograph it would, however, be difficult, but some idea of its interior may be gained from the outside. As will be seen, the house has two storeys. On the ground floor are the kitchen, larder, living room and parlour, and these are connected with the semi-detached wash-house and store by a pergola. The first floor contains three bedrooms and a bathroom. The hypercritical will, perhaps, say that the rooms are too crowded with electrical apparatus. The General Electric Company recognise this, but thought it wiser to take the opportunity to show the full range of their domestic electrical apparatus under favourable conditions, and, it may be added, in answer to this criticism, that nothing is shown in any room which might not conceivably be used there.

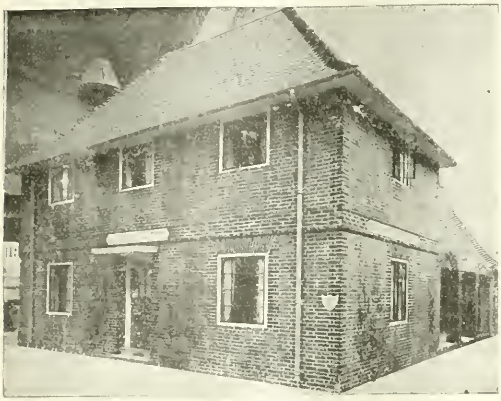


Fig. 4.—Outside View of the "All Electric" House.

Bell-Ringing Transformer.

An interesting exhibit at Messrs. S. G. Leach & Company's stand, which has been added since our first visit, is the bell-ringing transformer which has been specially designed for use in houses so that the electric bells may be rung off the mains. These transformers are made in two types, one of which is standard for ordinary houses and the other is of a heavy duty type for such places as hotels, factories, &c. These transformers (Fig. 5) are covered in blue glaze porcelain, for which arrangement the following advantages are claimed: that it will not corrode, that it is an excellent insulator, that it is non-resilient so that the buzzing or humming inherent to all alternating-current devices is entirely muffled, that it is light in weight and that it adds greatly to the appearance. These transformers are made in all the ordinary frequency and voltage ranges. For ringing ordinary bells of the 3-in. or 4-in. size the capacity is about 3 watts, while for larger bells transformers of 6 to 8 watts capacity are made.

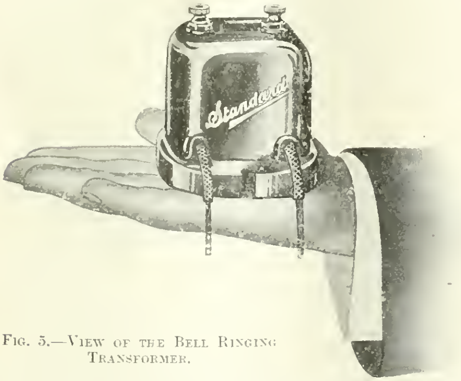


Fig. 5.—View of the Bell Ringing Transformer.

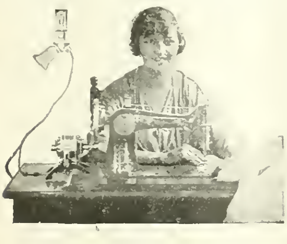


Fig. 6.—Electrically Driven Sewing Machine.

Among the other electrical apparatus of a domestic character which is being shown on this stand is the electrical driven sewing machine, illustrated in Fig. 6. This, as will be seen, is operated from an ordinary lamp pendant. It should be welcomed in those very wide circles where the sewing machine is an essential part of the domestic economy.

Vacuum Cleaners.

Amongst the large number of vacuum cleaners of more or less engineering design special mention should be made of that placed on the market by the Hoover Suction Sweeper Company. Those who have visited the United States will know the large application which this particular sweeper has had in that country. In general appearance it does not differ very greatly from the ordinary run of electrically-driven sweepers. The motor runs with its shaft vertical and drives the sweeper by means of a rubber band which is crossed so as to give the necessary motion to horizontal brushes. A special feature of this sweeper is the adjustment which can be given to the brushes and the roller so that wear is taken up as it occurs. In addition to this all parts are easily replaceable. The motor switch is placed directly on the casing of the sweeper and is operated by the foot. This arrangement, it is claimed, is much more durable and trustworthy than having the switch in a cord attached to the handle. A special feature of this sweeper is the way in which it lifts up the carpet by suction and thus enables the dirt to be drawn into the cleaner in a very easy and efficient way without damaging the fabric.

Country House Lighting.

Messrs. Strode & Company, Ltd., are exhibiting a good deal of interesting plant specially designed for country house lighting, of which work, of course, they make a speciality. This plant consists of a horizontal low-speed oil engine burning paraffin. It is controlled by a governor which ensures steadiness in running and economy in fuel consumption. It is claimed that constant attention and regulation of the plant are unnecessary and that it is so simple in character and easy to manage that only relatively unskilled labour is necessary for its maintenance. Where space is a consideration, a low-speed dynamo is direct coupled to the engine, but a belt drive can be supplied where this is preferred and space is available. The same remarks as regards simplicity apply also to the design of the dynamo. The generating plant has to be run about three or four hours in the 24 to charge the battery. This, of course, is usually done in the day time and for the remainder of the time the energy required by the installation is taken from the battery. Adequate switchgear for controlling the battery and the house circuits is provided.

This firm were also showing a number of electric heating and cooking utensils. These have the interesting feature that they are made entirely of aluminium and thus combine lightness, strength and cleanliness. Each unit is fitted with electric heating elements which can be easily replaced, and it should also be pointed out that there are no soldered joints. A series of indirect lighting fittings were also on view. These have been designed with the idea of combining the advantages of both the indirect and semi-indirect systems. The indirect illumination is obtained by means of a special reflector having two confocal curves on the upper part of the fitting. The bowl is directly illuminated at the same time, so that a soft and diffused light is obtained.

General Housing Exhibits.

Every conceivable means of building houses other than from brick seems to have been devised, and many methods are interesting from the point of view of their adoption for the rapid construction of sub-stations, as well as from an engineering and a housing viewpoint. A specimen house erected for their own employees at Dormanstown is shown by Messrs. Dorman, Long & Company, Ltd. This is constructed of steel frames encased in expanded metallic material, sand and cement. The house is shown partially finished, so that the method of construction can be seen throughout. The Unit Construction Company show a method of employing concrete in conjunction with pressed steel stampings for window frames, doors, &c., and thus entirely eliminating the use of wood in the house. No-flame paint, a water-paint preparation of a non-inflammable nature, is another item of interest to engineers. It removes the danger of flames spreading by igniting woodwork, and therefore offers advantages for use in test rooms, cinema projection boxes, sub-stations, &c.

As previously mentioned, the majority of standholders employed electricity at the illuminant, but though many artistic and beautiful effects were obtained with the use of silk shades and inverted bowl fittings, there seemed to be lacking on the part of electrical exhibitors a good display of scientifically designed illuminating glassware.

At the times our representatives visited the exhibition the attendance was good, but, due to the excellent arrangement of exit and entrance to the houses in particular, there was no overcrowding or discomfort. Due attention could be given by attendants on the stands to those of the public who inquired for information.

Correspondence.

THE DIRECTION OF E.M.F. AND THE RIGHT-HAND RULE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The following derivation of the right-hand rule for the direction of E.M.F. in a conductor cutting a magnetic field may be of interest to your student readers. As a mode of presentation, it is, so far as I know, new.

Consider a positive charge, q, moving in the direction M (Fig. 1), with velocity v. This is equivalent to a current, i, and gives rise to a magnetic field, H, by the usual corkscrew rule. When the charge moves through a magnetic field, B, the latter is distorted, and there is a lateral force, F, on the charge in the direction shown. A negative charge, q, moved in the same direction, and with the same velocity, experiences an equal force in an opposite direction (Fig. 2).

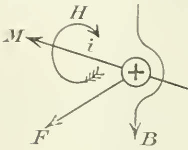


Fig. 1.

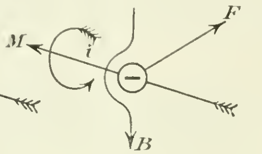


Fig. 2.

The movement of an uncharged conductor, which on the electron theory of matter contains an equal number of positive and negative electrons, gives rise to no steady magnetic field; but the positive electrons are forced to the left, the negative electrons to the right, in the figure (Fig. 3). The former are anchored into the atomic structure, there is, therefore, polarisation, but no steady electric movement in that direction. There are, however, free negative electrons, and these are driven in the direction F, forming when the circuit is closed the usual conduction current in the wire.

Inspection of the figure shows that the right-hand rule is satisfied, the generated E.M.F. being taken as positive in the direction of motion of the positive charge. The rule is, then, derived as a consequence of the ordinary corkscrew rule for the direction of magnetic field round a current, a right-hand linkage of electricity and magnetism.

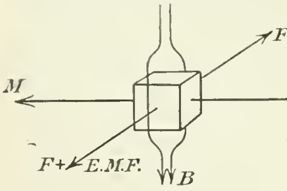


Fig. 3.

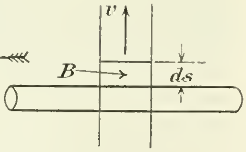


Fig. 4.

The conception of matter as a mass of equal electric charges of opposite sign may be used to illustrate the Faraday-Maxwell law $E = \frac{dN}{dt}$, the sign being unimportant. Consider the lateral movement of unit length of a wire at right angles to a magnetic field of force B. The current equivalent to a charge q moved at velocity v is $i = qv$, in space perpendicular to the wire (Fig. 4).

The force on this element is, by methods which do not involve the final result, $F = Bi$ along the axis of the wire.

So that $F = Bq\frac{ds}{dt}$. But $Bds = dN$, and $\frac{dN}{dt}$ is the total flux cut per second by the element.

$\frac{F}{q}$ is the force on unit charge, that is by definition the electric field E per unit length. Hence $E = \frac{dN}{dt}$.

This holds whether the element is conducting or non-conducting. In the latter case there is polarisation proportional to the speed, but no steady current—I am, &c.,

Newcastle-on-Tyne, Feb. 12. W. M. Thornton.

LOSSES IN TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the interesting article in your issue of the 13th inst. on Transformers, by Mr. R. O. Kapp, the conclusions drawn, although they may be correct from a purely theoretical standpoint, are in practice only applicable to comparatively small transformers as used for lighting purposes.

In the case of the great majority of transformers — those used for power purposes — a much broader view must be taken than annual economies in the no-load losses. These losses, in any case, are but very small compared with losses occurring in the generating plant and transmission lines. The purchaser is primarily concerned with reliability, the manufacturer with reliability and production.

Transformers with a high ratio of copper loss to iron loss are more likely to develop hot spots; also, they are mechanically weaker on surges of load and short-circuits than others, because to get such a ratio the relative number of ampere-turns is increased; hence, also, the force acting during short-circuits, &c., on the winding. A breakdown is a much more costly affair than a slightly higher core loss, and I would refer to an article in your issue of October 16, 1914, by Mr. D. W. Roper, which demonstrates the greater liability to failure shown by even small transformers having a high copper loss ratio.

Mr. Kapp does not appear to have considered the effect of frequency. Most manufacturers find that for the usual 50 cycles a good ratio of *hot* copper loss to core loss is about 1·5 to 1. Using the same standard frames, a ratio on 25 cycles will be obtained of about 2·5 to 1, or 3 to 1. This is as high a value as is safe, and anything beyond this will restrict the output on overload, since the losses will then increase very greatly.

Manufacturers are concerned with standardisation and production, hence the suggestion that purchasers should specify the ratio is a particularly mischievous one, since it would operate against standardisation and impede output. It is better to accept the designs which makers have arrived at after years of experience and thought. I am, &c.,

William C. Kennett,
Manager Transformer Dept.,
London, Feb. 14. Hackbridge Cable Company.

THE THERMIONIC VALVE AND ITS DEVELOPMENT IN RADIOTELEGRAPHY AND RADIOTELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the reply of Prof. Fleming on the above subject, I beg to thank Prof. Fleming for his willingness to refer to my Paper of 1916 on the three electrode valve in the next edition of his book.

The theory of the three-electrode valve expounded in my Paper has already been referred to by different authors in the following manner: Prof. Hazeltine writes in the "Proceedings" of the Institute of Radio-engineers for April, 1919, page 167: "Equations of this form ($i_p = e\ g_p + e_g g_m + C$) seem to have been first employed by Latour in The Electrician, December 1, 1916, in discussing amplification."

Mr. John Miller, of the Bureau of Standards in Washington, in his last Paper on "Dependence of the Input Impedance of a Three-electrode Vacuum Tube upon the Load in the Plate Circuit," discussing the case when measureable grid current exists, says: "All these facts are implicitly contained in the equations (5), derived by M. Latour in his Paper on the 'Theoretical Discussion of the Audion,' Electrician, Vol. LXXVIII, p. 280, 1916." The correctness of these equations (5) of mine is shown again by Prof. Press in the issue of the Electrician of January 9, 1920 (p. 35). In this Paper Prof. Press, discussing the work of Capt. L. B. Turner, derives for potential magnification and current amplification equations corresponding to equations (5) in my Paper of 1916. I am, &c.,

Paris, Feb. 10. Marius Latour.

[We regret we have had to hold over some Correspondence. — Ed. E.]

The Electrician.
FRIDAY, FEBRUARY 20th, 1920.
Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benhrotric Fleet London."

Electric Cooking & Heating—An Opportunity.

In organising the Ideal Home Exhibition, which is now taking place in London, the "Daily Mail" has given electric heating and cooking a chance to show what it can do. This opportunity has been taken full advantage of, as will be obvious from our description of the exhibits last week. The public, on their part, have taken great interest in what is to be seen. Olympia has been crowded on every day since the exhibition opened, and by the intelligent questions and apt comments heard on all sides leave no doubt that there is a general realisation of the benefits obtainable by the employment of modern apparatus in the house.

It would, therefore, seem that the makers of heating and cooking apparatus, supply engineers and the dispensers of propaganda have every reason to be pleased. We agree. But while not wishing to lop off the rising load curves of their satisfaction by the use of the circuit-breaker of criticism, there are one or two possible improvements in design and policy to which we may call attention.

The Popularity of Electric Heating and Cooking.

For, strange as it may seem, electric heating and cooking are becoming popular. But there are dangers in popularity. And the greatest danger is that we may be so satisfied with present conditions as to cease our efforts to improve the apparatus, thinking that because it sells well it is therefore perfect. This is far from being the case. For while a good deal of the modern apparatus fulfils engineering conditions (thus marking an advance over the state of things some years ago), a great deal of it has not become so suitable for domestic work as we should like to see it. Designers must consider the point of view of the cook and the householder, and not a bad way of doing so is to take one's cook or one's wife to Olympia and listen carefully to what she has to say about some of the electrical apparatus. A woman generally knows what she wants.

Looking at the matter from this point of view, one thing upon which there is agreement is that adequate arrangements are not made for cleaning the apparatus. Every cook knows that fat flies into the most out of the way places. All electric cooking apparatus should, therefore, be as free as possible from crevices in which fat and dirt can lodge, and should be so arranged that every part is accessible and can be easily cleaned. We were told on one stand that this was not necessary, because on that cooker the element never became dirty. As there was nothing between it and the food being cooked except free atmosphere, this was nonsense. Yet it is the sort of nonsense that is still being talked to non-technical visitors, and—to put it mildly—it does a great deal of harm.

A Kitchen Not a Workshop.

It is not yet realised that a well-fitted tool chest is not part of the equipment of the ordinary kitchen. On much of the electrical apparatus nuts have to be slacked back and screws unscrewed to get at parts which require cleaning. This means that the cleaning is not properly carried out, and electric cooking soon receives a bad mark because it smells! The designer apparently presumes that no one uses electric cooking apparatus but the family of an electrical engineer, who, of course, is always at hand with ready pliers. But that is not true now, if it ever was, and the fastenings on all apparatus should be made so that they can be adjusted by unskilled fingers.

It may be argued that if the apparatus is made to take to pieces too easily it will be taken to pieces too often, and thus acquire unpopularity because it cannot be put together again. Experience with the motor car does not bear out this view. Such handling may bring good rather than evil in its train, for it will expose weaknesses in design. And the criticism of the amateur is not to be despised.

The Need for Simple Apparatus.

The designer must, therefore, get into his head this fundamental fact—that apparatus not for the skilled worker, but for the amateur is what is required. This is the more necessary because the amateur is nowadays generally favourably inclined towards the electric idea. But that tendency is yet but a delicate flower, and he is easily discouraged. There are, of course, cases where education is necessary, or where the cook or housekeeper takes an irradicable dislike to electric cooking for some unknown reason, finds every conceivable fault, and sometimes does not stop short of doing actual damage in order not to be troubled with new fangled notions. Such cases are, however, few, and we do not despair of even those being settled by the tact of the electrical salesman.

The Importance of Salesmanship.

The salesman, indeed, is a most important factor, and is doing his part very well at the Ideal Home Exhibition. He has got good apparatus to show, and he is showing it; but he might show it even better. He does not yet quite tell the public what they want to know. He still talks about kilowatts, and, though the public are beginning to have some idea of what a kilowatt means, he might eradicate even those simple technical phrases. He does not yet quite realise that, though he is so well acquainted with electric cooking and heating as to be almost bored with them, that does not apply to most of his inquirers. The result is that he sometimes allows his natural boredom to get the better of him. Now, it is no good being angry with the old lady who thinks a volt has threads on it. She may have wealth sufficient to purchase many electric cookers, and so it does not matter what she thinks. If the salesman wants to get angry, therefore, he should get angry with himself for talking to people about things they do not understand.

Learning from Others.

Our remedy for this is a simple one. Let each salesman on a stand where electrical apparatus is being shown at Olympia make a point of visiting the stands showing other kinds of goods and asking questions. And let him mark how his questions are received, and let him mark the answers he gets. It may help to teach him salesmanship and perhaps also sympathy, for it is wonderful what silly questions can be asked about, say, furniture by those who know nothing about it.

Apart from this relatively minor question, however, the important point to realise, is that electric cooking and heating apparatus have passed out of the realms of Maskelyne and Cook into the regions of actuality, even in the public view. This is a great advance, though it may be imperceptible. To meet the changed conditions, therefore, both designers and salesmen must correspondingly alter their outlook, and, well as they have done, proceed to do still better. With all the advantages at our disposal, progress cannot then help being most marked.

The Electricity Commissioners.

It is officially announced that the Minister of Transport, in pursuance of his powers under the Electricity (Supply) Act, 1919, has appointed Sir John F. C. Snell, M.Inst.C.E., to be Chairman of the Electricity Commissioners, and Mr. H. Booth, O.B.E., of the Board of Trade, Mr. W. W. Lackie, C.B.E., M.Inst.C.E., M.I.E.E., and Mr. Archibald Page, M.I.E.E., to be Commissioners. All communications for the Commissioners should be addressed to the Secretary, Electricity Commissioners, Gwydyr House, Whitehall, London, S.W.1.

The following particulars of the careers of the new Commissioners will be of interest to our readers:—

The Chairman of the Commissioners, Sir **John F. C. Snell**, was born at Saltash, Cornwall, in 1869, and received his training at King's College, London, and the Finsbury Technical College. After a pupilage of four years with Messrs. Woodhouse & Rawson, he was engaged by Messrs. Crompton & Company in 1889 on central station work, main laying, &c. Later he was chief assistant to the late Major-Gen. Webber on country house and other installation work. In 1893 he entered the service of the St. Pancras Borough Council electricity department, and in 1896 he was appointed borough electrical engineer at Sunderland, a position he resigned in 1906 in order to devote his time to consulting work. He became one of the partners in Messrs. Preece, Cardew, Snell & Rider, but he recently retired from the firm on his new appointment. Sir John, who is a past president of the Institution of Electrical Engineers, and a member of the Council of the Institution of Civil Engineers, has acted as a consulting engineer for many electric power and traction undertakings, including the 1905 and 1905 electric power schemes of the London County Council. He was also a witness for the Postmaster-General in the arbitration proceedings connected with purchase of the undertaking of the National Telephone Company. During the war Sir John was engaged on Government work in connection with electric power supply; he served on several Committees, including the Board of Trade Committee on Electric Power Supply. He was also one of the five trustees appointed by the Army Council to form the first Metropolitan Munitions Board in 1915, and was afterwards a member of that Board.

Sir John Snell.

Mr. **W. W. Lackie**, one of the new engineering Commissioners, was born at Montrose in 1869, and was educated at University College, Dundee, and Glasgow University, where he studied under Lord Kelvin. Subsequently he joined the firm of Muir, Mavor & Coulson (now Mavor & Coulson); but when the Glasgow Corporation took over the electric lighting undertaking of that firm he transferred his services to them, entering the new municipal department as mains superintendent. In 1898 he was chief assistant engineer under Mr. W. A. Chamen, and on the latter's resignation in 1905 to join the firm of Bramwell & Harris, Mr. Lackie succeeded him as chief engineer, while in 1915 he became manager-engineer of the Corporation electric supply department. He is a past-president of the Incorporated Municipal Electrical Association, the West of Scotland Institution of Engineers and Shipbuilders, and has been chairman of the Scottish Centre of the Institution of Electrical Engineers.

Mr. **Archibald Page**, the third technical Commissioner, was born at Alloa, and was educated at the Heriot Watt College, Edinburgh, and the Royal Technical College, Glasgow. He served his apprenticeship in his native town, and was later with Messrs. Mavor & Coulson, Glasgow. Subsequently he joined the Glasgow Corporation electricity department, and steadily rose until he became chief assistant engineer, which position he held till he went to the Clyde Valley Electric Power Company as assistant general manager. On the death of Mr. Starr last year, Mr. Page became general manager of the company. He is a member of Council of the Institution of Electrical Engineers, and is a past-president of the Scottish local centre of the Institution.

Mr. W. W. Lackie.

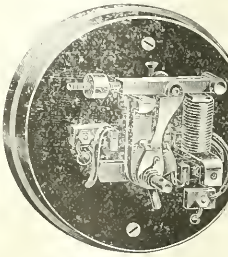
Mr. A. Page.

Mr. **H. Booth**, O.B.E., was principal clerk in the Board of Trade, and served as a member of the Electric Power Supply Committee. He has an extensive experience of the administration of the legislation governing electricity supply, having been for many years clerk in charge of the work under the Electric Lighting Acts.

The Commissioners, with the exception of Mr. Booth, whom we understand has not been photographed for many years, have kindly consented to the publication of the photographs which we reproduce herewith.

An Excess Current Controlling Device.

Messrs. Ward & Goldstone, Ltd., Sampson Works, Salford, Manchester, have recently patented and placed upon the market the "Albert" excess current controlling and circuit safety device. The primary object of the device is to provide a certain means for preventing the consumption of current in excess of that intended for a particular circuit, and is particularly useful in blocks of flats, hotels, &c., For instance, in a large block of flats, though there are many tenants, there is usually one controlling meter dealing with the total consumption of the building, and it has been difficult to prevent the excessive use of current over that arranged for in each flat. Again, in hotel suites the apparatus will assist in avoiding the taking of excess current for additional lights, radiators, &c. By inserting the "Albert" current controller, should any excess current be taken, the circuit is automatically broken on the overloaded circuit only. The addition of an extra lamp or current consuming device, beyond the number arranged for, immediately cuts off the supply. The supply can, however, be restored by cutting out the device taking the excess current and then turning the switch handle on controller. The manufacturers claim that, as a safety device it is far more reliable than a fusible wire cut-out, as the circuit is broken much more quickly than a fuse wire is melted. It also ensures protection for the lamps against an excess of voltage. The "Albert" Current Controller is claimed to be absolutely reliable as the apparatus automatically breaks the circuit with the slightest current excess. After the cover is sealed the instrument cannot be tampered with unless the seal be broken. After being regulated, the instrument is not liable to get out of order, and will withstand repeated violent short circuits without requiring adjustment.



"ALBERT" CONTROLLING DEVICE SHOWN WITHOUT COVER.

The "Albert" Controller can be regulated, when fixing, to break the circuit at the arranged maximum current, and provision is made to provide ample range of regulation. It is made for certain standard capacities for 100 to 110 volt or for 200 to 250 volt circuits.

Joint Industrial Councils.

A meeting of the No. 6 District Joint Industrial Council was held in Bristol on Monday, Mr. H. Faraday Proctor, Chairman of the District Council, presiding. The Chairman reported the completed list of the employers' representatives as follows :—

Mr. H. Faraday Proctor, Ald. G. Pearson and Councillor A. E. Thomas, Bristol ; Ald. Sir H. T. Hatt, Bath ; Mr. W. J. Bache, Cheltenham ; Mr. F. H. Corson, Gloucester ; Mr. G. Charlton, Weston-super-Mare ; Mr. A. B. Randall, Salisbury ; Ald. G. H. Stevens, Swindon ; Mr. H. Leather, Minehead ; Councillor J. E. Kingsbury, Taunton ; and Mr. J. Eliot Mills, Keynsham.

A return of the undertakings in the area which are paying the 5s. award was reported ; also a return of the undertakings which have adopted the 47 and 48 hours week, and the Secretary was instructed to communicate with those undertakings which had not yet adopted the 47 and 48 hours week. It was decided that agendas and minutes be circulated only to the representatives of the District Council and that it be left to the members to inform those they represent of the matters dealt with at the meetings. A levy to meet the expenses of the District Council was decided upon, an equal amount being required from the undertakings and from the Trade Unions. The date of meetings has been altered from the third Monday to the last Monday in the month, so as to allow of sufficient time for the minutes to be forwarded to the National Council for their meetings.

At a conference of representatives of supply authorities and workers at Newcastle-on-Tyne on the 10th inst. it was decided to form a District Council for the North-East Coast under the National Joint Industrial Council for the Electricity Supply industry. The area includes Northumberland and Durham and the Cleveland district of Yorkshire, and the District Council will be composed of 12 representatives of employers and 12 of employees.

A Hastings Bulk Supply Scheme.

An important forward step in connection with electricity supply has been taken by HASTINGS Corporation on the advice of the borough electrical engineer, Mr. Russell F. Ferguson. Before the War the Electricity Committee considered a report by Mr. Ferguson, who advised that, having regard to the largely increased demand for electric current and to the impracticability, owing to the restricted space at the existing works at Earl-street, of making provision for future extensions of plant, it was desirable to consider the question of establishing a larger generating station on a more convenient site. Owing to the War the matter remained in abeyance, but Mr. Ferguson evolved a scheme for a large modern generating station on a site near the L.B. and S.C. Railway at Bulverhythe, at which water for condensing purposes could be obtained from the sea, and from which station current could be supplied in bulk or otherwise in an area including the Borough and extending to Rye Harbour on the East, Pevensey Sluice on the West, and to Tenterden and Cranbrook northward. The Town Clerk communicated with the various local authorities in the area, the Hastings Tramways Company and the railway companies in order to ascertain the amount of support the scheme would receive, and also with the L.G. Board and the Board of Trade. The replies received from the Local Authorities were generally of a satisfactory character, and at a subsequent stage Mr. Ferguson saw Sir John Snell, the Chief Electricity Commissioner, and Mr. Booth, Sir John intimated that as the plant at the existing station was obsolete and the debt practically paid off, and as Hastings must have more power and were unable to obtain a bulk supply from any outside source, he advised that it would be correct for Hastings to establish a new station such as that projected. Sir John recommended a new station with an ultimate capacity for a 15,000 to 20,000 kw., but that Hastings should be content for the present to give a supply to Bexhill and the tramways ; that the system should be changed from single phase 100 cycles to three phase 50 cycles, and the Corporation would then be in a position to give an extended supply if necessary later, and that the local authorities concerned could, in the meantime, be consulted regarding the supply in the wider areas.

Accordingly the Corporation has decided on the recommendaton of the Electricity Committee, to instruct Mr. Ferguson to prepare a scheme for a bulk supply generating station at Bulverhythe on the lines suggested, and he has been instructed to visit such up-to-date generating stations as he may deem necessary in order to obtain information with regard to plant and machinery, &c.

Recent Publications of the Bureau of Standards.

Three interesting publications on electrical subjects have recently been issued by the Bureau of Standards, Washington.

"THE DETERMINATION OF THE OUTPUT CHARACTERISTICS OF ELECTRON TUBE GENERATORS."

Owing to saturation and rectification effects in three-electrode vacuum tubes, the currents which they deliver to any type of output circuit, when used as a generator, are heavily loaded with harmonics. Experimental results indicate that the frequency of the oscillating currents generated is the natural frequency of the output circuit. Hence this circuit behaves as a filter in series with the tube and the direct-current power system, and the useful output current is approximately sinusoidal, whatever the distortion of the tube currents, depending in amplitude solely upon the fundamental constituents of the tube currents. General expressions are derived for the power and current output in terms of static characteristics of the generating tube, and are corroborated by experimental results obtained with a particular tube.

"PRINCIPLES OF RADIO-TRANSMISSION AND RECEPTION WITH ANTENNA AND COIL AERIALS."

The functioning of the two principal types of radio-aerials is worked out quantitatively from fundamental electromagnetic theory. Experiments have verified the formulas and conclusions presented. Formulas for the current received in either antenna or coil aerial in terms of current in either type of transmitting aerial are given, as well as comparison formulas giving the relative performance of antenna and coil aerials under various conditions. The advantages of the condenser type of aerial are presented. The theory and nature of radiation are discussed and applied to the elucidation of some current fallacies. The basic principles of design of aerials are given. Desirable lines of future research are pointed out. The use of the coil aerial as a direction finder, interference preventer, reducer of strays and submarine aerial are not among the subjects treated.

"VARIATION IN DIRECTION OF PROPAGATION OF LONG ELECTROMAGNETIC WAVES."

The observed direction of radio-waves as obtained with a direction-finder varies with time when long waves are used such as those from very high power stations. The variations of direction are of the order of 90 deg. for very long waves. No such large variations are found for short damped waves produced by spark apparatus. A method of increasing the sharpness of determination of direction has been worked out. A theoretical explanation of the variations of direction is given, based on the existence of media in the earth's atmosphere capable of reflecting and refracting the waves.

Legal Intelligence.

Universal Radio Syndicate, Ltd. v. Baxendale.

On the 12th inst. Mr. Justice Roche heard an action in which the Universal Radio Syndicate, Ltd., claimed (by the liquidator) damages against their former managing director, Mr. Arthur Baxendale, in respect of an alleged breach of agreement, or in the alternative an account of profits made on the work undertaken in breach of duty.

Mr. Douglas Hogg, K.C., in opening plaintiff's case, said the claim related to the erection of a Poulsen wireless installation at the Eiffel Tower by Mr. Baxendale in conjunction with Mr. Elwell, who was managing engineer to the syndicate. The syndicate held a licence for the Poulsen system, and Mr. Baxendale was managing director under an agreement of September, 1912. It was desired to have an installation at the Eiffel Tower by which communication could be set up with America. In the early part of 1913 Mr. Baxendale was able to arrange with Mr. Husson in Paris for him to act for the syndicate in endeavouring to obtain authority to use the Eiffel Tower for trying the Poulsen system, and in March of that year he communicated with a French telegraph company interested in the installation of the wireless system, after which there was a long correspondence. At the end of December, 1914, the syndicate had failed to get sufficient capital to carry out their option to buy the Poulsen system, and on January 19, 1915, they went into voluntary liquidation, and on January 21 Mr. Baxendale wrote a letter which modified his original agreement under which he was paid at the rate of £1,500 a year. On February 11, 1915, he proposed on payment of £500 to forgo his claim against the syndicate, and, in consideration of that payment, he undertook to continue to give every assistance in the liquidation until the following September, and practically to give advice up to January 1. There was reason to believe that at about that date a letter was written by Mr. Husson to Mr. Baxendale, as managing director of the Radio Syndicate, regarding the Eiffel Tower contract and other letters on the same subject were written to Mr. Elwell. At the end of March, 1915, Mr. Elwell went to France, and on his return he invited various companies to tender for different parts of the installation at the Eiffel Tower. When, in May, it was found out what was going on, Mr. Baxendale was spoken to. He (Mr. Baxendale) admitted that he had sent Mr. Elwell because he did not think the syndicate could carry out the contract. The correspondence showed that Mr. Elwell was acting for Mr. Baxendale, and that the contract for which they were negotiating was for £98,500 odd for an installation for purely military purposes. In November, 1915, litigation was commenced between Mr. Elwell and the syndicate in respect of his salary. Counsel then read correspondence for the purpose of showing that in 1914 and 1915 Mr. Baxendale was negotiating with the authorities in France, especially the military authorities in view of the creation of the installation, and that in 1915 he sent Mr. Elwell out to France to try to get the contract for himself.

Mr. Compston, K.C., for defendant, submitted that the appointment of Mr. Baxendale came to an end upon the liquidation. After that, Mr. Baxendale was under no obligation, except that he accepted some responsibility in consideration of the payment of a sum of money to him.

Evidence was then given, and Mr. Viggo Gambil, managing director of the British and Overseas Engineering Syndicate, and at one time director of the Radio Syndicate, gave evidence as to certain contracts which had been made for the Universal Syndicate with defendant for the supply of parts for the installation. In cross-examination he said that the syndicate failed to carry out a reconstruction. The patents reverted to the original owners when the syndicate went into liquidation.

At the close of plaintiff's case, Mr. Compston submitted that there was no case for him to meet, as the documents did not reveal any implied terms with regard to the inability of Mr. Baxendale to carry on any business he liked so long as he, to the best of his ability, assisted the liquidator in winding up the syndicate's affairs. He submitted that there was no contract, and if there were, it had not been broken.

His Lordship: I think, Mr. Compston, there is a case for you to answer.

Mr. Arthur Baxendale gave evidence as to what had taken place after the liquidation was decided upon and the position taken up by the advisory committee. That committee was opposed to taking up any new business. He had been absolutely ruined by the collapse of the business in which he had put £1,200. He told his co-directors that he was going to work as hard as he could for the reconstruction of the company, but he was unable to bring it about. At the end of 1915 the patents were nearing expiration, and had now expired, the station being worked by the Government.

His Lordship in giving judgment, said that defendant had entered into a contract on his own behalf, and must account to the company for any benefit he had received under it. He agreed that when the liquidation came into force defendant was no longer bound by his contract of employment, but by an agreement he undertook to render advice and assist in the liquidation. He was satisfied that the beneficial winding up of the company required that such a contract should be entered into; he was also satisfied that the company could have got the contract with the French Government. Defendant did not offer that contract to the company, but in fact went behind the back of the company. He was in conflict with the advisory committee, and therefore secretly arranged with the French Government for business which might have become of considerable value.

Mr. Hogg said he was prepared to take judgment for £200, but on payment of costs judgment was suspended to give defendant's counsel time to consider the position.

Commercial Topics.

A Finnish Industries Fair.

It has been arranged to hold at Helsingfors from June 27 to July 6 next an Industries Fair, which should give engineers and manufacturers a good opportunity of showing British products and manufactures. There is much undeveloped water power available in the country, but many schemes are projected for erecting hydro-electric stations. Consequently there should be a demand for hydro-electric machinery, electric light fittings, electric motors, cables, &c. It is reported that tools, machinery, raw materials, half manufactured products, &c., are specially required, and price lists and catalogues would also be welcome at the Fair. A list of the materials and manufactures required can be inspected at Finnish Legations and Consulates, and inquiries can be addressed: Finska Messan, Helsingfors.

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The Indian Trade.

Mr. E. M. Hughman, of Messrs. Pyne, Hughman & Company, electrical engineers and machinery importers, of Calcutta and Bombay, who is now on a visit to London, is enthusiastic over business prospects in India. He is of opinion that "the British manufacturer apparently does not realise the glorious opportunity which he now has of capturing practically the whole of the trade in India and the Far East." The low rate of exchange favours the British exporter. Manufacturing firms may be inundated with orders, but we would like to impress upon them the necessity of not neglecting the colonial and foreign purchaser, more especially the former. In India many industrial schemes are projected, and these will no doubt mean an increase in the demand for electrical energy for power and traction, which should in turn mean increased orders for electrical plant, and motors and apparatus for British manufacturers and exporters.

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Electrical Plant for China.

We have recently referred to the great possibilities for engineering firms in China and pointed out the necessity for British firms to keep in touch with developments so as to be prepared to meet local requirements. The Shanghai special correspondent of "The Times" Trade Supplement now reports that there is a very large and increasing demand for electrical plant and machinery from all over China, and he regrets "that the big British companies are not doing more to capture this trade. As the business needs a highly-trained technical staff it is advisable for manufacturers to have their own offices and men here." At present the British Municipal Council at Tientsin is calling for tenders for turbo-alternators. A large industrial undertaking wishes to increase its power-generating plant from 500 H.P. to 1,000 H.P., but it will not apply to any of the local firms because they are only dealers. What is wanted is a resident electrical engineer who will advise the directors as to the type of plant required.

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Cheap Power in Australia.

The big scheme of the State Government of Victoria for the utilisation of the Morwell brown coal deposits in the generation of electrical energy must have, if carried out, an important effect on the industrial and commercial life of the state. "The Times" reports that Mr. C. H. Merz, who is now in Melbourne, has approved the project, but he thinks the cost of the power station will be 25 per cent. more than estimated. Local manufacturers are delighted with the prospect of cheap power. It was originally estimated that an expenditure of over £3,000,000 would have to be incurred, and statutory powers will be necessary before proceeding. Boring at Morwell has revealed within an area of one square mile the existence of between 120,000,000 and 150,000,000 tons of coal which can be won by the open cut method. These supplies would be sufficient to provide a continuous output of about 100,000 h.p. for 150 years. There are estimated to be reserves of 20,000 million tons of brown coal in the district.

In order to make the coal available as fuel for industrial and domestic purposes it is recommended that authority be obtained to proceed at once with the opening up of the Morwell brown coal fields. A sum of £30,000 would be provided for an experimental installation of the first unit of the necessary crushing, drying and briquetting machinery. It is also urged that representations be made to the Commonwealth authorities with the object of effecting a reduction of the Customs duties payable on many items of plants required for the Morwell scheme which cannot be made in Australia. The report stated that money should be raised for the following purposes:—Opening up Morwell brown coal fields, £221,000; electrical system, £2,516,382; township at Morwell, £150,000; briquetting plant, £30,000, or a total of £2,917,382. In meeting the immediate pressing needs of an adequate supply of electric energy for the Melbourne area it is suggested that any scheme must be considered only as providing the nucleus of a system to meet the future power requirements of the State both for industrial and domestic purposes. The scheme to meet the requirements in the metropolitan area in 1923 is regarded as the first step of a greater scheme having for its ultimate objective the linking up of all the available sources of power supply, whether steam or hydro-electric, for the benefit of the entire State.

British electrical manufacturers and exporters would be well advised to watch developments in connection with this important scheme, as there will be many contracts to let for electric generating plant, transmission lines, briquetting machinery, &c.

Electricity Supply.

Swansea Finance Committee has approved the proposal to utilise two sums of £8,000 and £3,000 out of the sinking fund of the electricity undertaking for new capital purposes.

Accrington Gas and Water Board have decided to apply for sanction to borrow £133,000 for additions to their works. These include the purchase of storage battery, locomotive, &c.

Barrow-in-Furness Corporation have been asked to appoint representatives to meet a representative of Messrs. Vickers, Ltd., to discuss water supply and hydro-electric development in the Duddon Valley.

Arrangements for the future public lighting of Bath are under discussion. It was originally intended to order 900 new gas lamps to replace defective ones, but it has now been decided to order only 500 lamps and to make a further extension of the electric lighting.

Newport (Mon.) Town Council has adopted a recommendation of the electricity and tramways committee that the salaries of the general manager (Mr. N. J. Young) and the borough electrical engineer (Mr. A. Nichols Moore) be increased from £633 per annum to £800 from Jan. 1, 1920, £850 from April 1, and £900 from Jan. 1, 1921.

Interviews are to be arranged by Littleborough Urban Council with their consulting engineer and with Mr. F. H. Rudd, electrical engineer to Rochdale Corporation, in order that they may be able to submit terms for the supply of electricity to several large firms who are contemplating the erection of big factories in the district.

Newcastle-under-Lyme Council has applied for authority to borrow £2,000 for mains and services. It has been decided to supply electric current to tradespeople for shop window lighting at 5d. per unit, subject to there being a minimum of three lights to each shop, and also to the annual payment of 15s. for the installation of the necessary time switch.

Easton Urban Council, having been informed that its application for an electric lighting order should be dealt with by the Electricity Commissioners, has decided to urge upon the Commissioners the necessity for carrying out the proposed electric supply scheme, as the existing gas lighting is inadequate and inferior.

After an interview with a deputation of the local Electricity Users' Association, Peterborough Corporation has decided to proceed with the electricity extension scheme recently recommended by Mr. Selvey, of Sheffield, who will be engineer and manager of the electricity undertaking. The scheme involves an expenditure of about £100,000.

Ammanford Council recently inquired of Mr. W. Herbert, proprietor of the local electric works to fix a price for the undertaking, and Mr. Herbert now states that he will sell at £15,000—£1,000 cash and the balance on completion of the contract of sale. A special meeting of the Council will consider the matter as well as Mr. Herbert's proposed application to the High Court to vary the existing lighting contract.

On the advice of Mr. R. H. Scotson, borough electrical engineer, Middlesbrough Corporation has applied for sanction to borrow £69,000, including £20,000 for two gas-driven sets, and £49,000 for cables, mains, rotary converter, &c., to cover a year's requirements. It is also proposed to lay five tramway cables, &c., at a cost of £3,393 10s. 10d. with £606 9s. 2d. for laying and jointing. The salary of Mr. R. H. Scotson has been increased from £550 to £700 per annum.

By a unanimous vote Kirkaldy Chamber of Commerce have requested the Town Council, in view of its inability to give an adequate supply of electric power to local manufacturers and the pressing need of the power for industrial purposes, to allow the Fife Electric Power Company's system to be introduced into the town in order that manufacturers may obtain a sufficient supply of power.

At the same time, the Town Clerk, who has prepared a long report on the subject, advises the Council to sell its electric supply undertaking. Apparently there is a great demand for electricity in Kirkcaldy, but the Electricity Commissioners will not allow the Council to extend the existing generating station or build a new one. The Commissioners desire that Kirkcaldy should sell its station and take a bulk supply, and the town clerk (Mr. Macindoe) is of opinion that the town should not only do that but also endeavour to sell the distribution cables and distribution rights. The time has also come when the Council should weigh seriously whether they should not attempt to sell the tramway undertaking. The success of the undertaking and the fares would depend to a considerable extent on the price of current, which would, in future, be in the hands of the Fife Power Company.

Reporting on the demand for electrical energy the Stoke-on-Trent electrical engineer (Mr. C. H. Yeaman) states that the winter load had exceeded expectations, that the provision of more plant and the commencement of a new generating station is urgent, and that until such additional plant is available it was undesirable to remove any of the larger old steam engine generating sets from the sub-works. This winter's peak load was 5,445 kw., and the available plant capacity is only 3,000 kw. Letters from Mr. J. H. Rider, consulting engineer, state that the engineering part of the report which he had prepared after consultation with the Engineers' Committee of the Joint Conference of Local Authorities in the North-West Midlands would be unaltered, and he recommends that a power station should be erected on the site proposed, to have an ultimate total caacity of 30,000 kw, and as a first instalment, that four 5,000 kw. alternators be erected, either for the Stoke-on-Trent Corporation on its own account, or for a joint electricity authority for the whole area. The Electricity Committee has agreed to take all possible steps to acquire and provide a new generating station without delay, and it has endorsed the recommendations of Mr. J. H. Rider and Mr. Yeaman.

Electric Traction.

This week Glasgow Corporation tramways department is making a trial with the formation of queues for tramway purposes.

The salary of the tramways manager at Haslingden (Mr. Barnes Kay) has been increased to £350 per annum.

A sum of £5,419 is to be expended by Hackney (London) Borough Council in the purchase of four electric vehicles for house refuse collection, and £1,883 on a garage and charging plant.

Ashton-under-Lyne Tramways Committee has decided to abolish the 1d. fares on the municipal tramway routes and to substitute a 1½d. minimum.

A proposal to extend the Underground Railway from Finsbury Park to Enfield has been submitted to the Minister of Transport, and is being considered by the permanent officials.

The tramway employees of Hull Corporation have re-affirmed their decision "not to work any more overtime until the permanent staff is put on a workable basis." Most of the overtime is worked on Saturdays in connection with football matches.

There is an important project for the construction of light railways in North Wales and a conference of representatives of the counties of Denbigh, Merioneth and Carnarvon is to be held to consider the matter. The Mayor of Ruthin (Councillor Lecomber), Messrs. Thos. Ellis (Llangwm), W. H. Williams (Llanrwst) and Mr. W. G. Dodd will represent Denbighshire.

The National Transport Workers' Federation has sent in an application for an increase in wages for all tramway and omnibus workers of such an amount as will bring the wages up to 44s. a week above pre-war rates. The application of the tramwaymen will come before the Joint Industrial Council for the tramways industry on the 26th inst. Last summer a demand was made for an increase of 10s. a week, and after arbitration an increase of 4s. a week was awarded in October last.

Two 2-ton Electric Vehicles are being supplied by the General Vehicle Company to the Metropolitan Railway Company, which is making an experiment with "Electrics" for the collection and delivery of parcels. One vehicle has been supplied and is used at Baker-street station. It is fitted with a 44 I.M.V.7 "Ironclad" battery of the Chloride Electrical Storage Company, and having a capacity of 226 ampere-hours at a five-hour discharge rate. It has a speed of 10 miles an hour, and will run 35 to 40 miles on one charge.

In a report by the Highways Committee to the London County Council on the proposal to obtain power to increase the fares on the Underground Railways and to abolish workmen's fares, &c., it is stated that the abolition of workmen's fares may throw an undue strain upon the Council's tramways during the "peak-load periods" of the day, when it is scarcely possible for the railways and tramways to deal with existing traffic. The Committee think that the companies should be required to run a certain number of trains, with adequate accommodation, at those times of the day to which this consideration applies. Any financial advantages resulting to the "tube and 'bus combines" from the authority to increase fares should not be used to assist the Omnibus Company in its competition with the Council's tramways.

Imperial Notes.

The Municipal Council of Suva (Fiji) has secured an ordinance authorising it to construct, operate and control electric lines and works, and to generate, supply and sell electricity within and for a distance of three miles beyond the municipal boundaries. All plant machinery, including engines, dynamos, motors, transformers, insulators, &c., imported into the colony for the original construction of any and every part of the works authorised by the ordinance will be free of duty.

At the recent meeting of the Great Indian Peninsula Railway Company, the chairman announced that the investigation into the question of electrifying certain portions of the line had been completed, and Messrs. Merz & McClellan, who had carried out the surveys, had been appointed consulting engineers. The report dealt with the suburban sections from Bombay to Kalyan, and the main line to Bhusaval on the north-east and Poona on the south-east. It is proposed to commence with the conversion of the section from Bombay to Kurla, including the Harbour branch, and the matter is under the consideration of the Government of India, which is friendly to the electrification scheme, as it would contribute to economy, and enable a better service to be given.

An electrical engineer of the Westinghouse Electric International Company has reported to the Government of Jamaica on the proposal to adopt electric traction on the railway of the colony, and to provide electric power for industrial purposes. The estimated cost of electrifying the railway, including the power station, equipment and transmission lines to supply other industries, is put at nearly $3,400·00. The power plants would cost $849,320·00, sub-stations $333,320·00, overhead construction $1,854,300·00, electric locomotives and motor cars $357,650·00, a total of $3,393,590·00. The "Times" Trade Supplement reports that the saving in the cost of operating the railway would be approximately $265,600 per annum, or 7·83 per cent. of the cost of electrification, assuming the supply of power to outside consumers at cost. The sale of power to outside consumers would result in a profit sufficient to increase the return on the cost of electrification to 10·5 per cent. If the scheme is carried out some of the power would be used to operate plants on some of the sugar estates, to supply power for the sewerage and for the lighting of the thoroughfares of Kingston and in other districts.

Telegraph and Telephone Notes.

Owing to the increase of traffic the Government of Finland has been obliged to enter into a new contract with the Great Northern Telegraph Company, of Copenhagen, for the use of a third submarine cable between Finland and Sweden, which, it is hoped, will be sufficient for present needs.

A Spanish Royal Decree, published in the "Gazette" of the 18th ult. set out the regulations, &c., for wireless telegraph and telephone installations in Spain. Permanent installations remain under the Decree of Feb. 8, 1917, and temporary installations are permitted for a limited period under certain conditions.

Ordinary Telegrams routed "Via Marconi and Pacific" are now accepted for Australia, New Zealand, British New Guinea, Cook or Hervey, Fiji and Marshall Islands, New Hebrides, &c. The charges are 2d. less per word than the cable rates. Messages may be handed in at Marconi House, Strand, W.C.2, and 1a, Fenchurch-street, E.C., or any post office.

On Monday a New Telephone Exchange was opened at Jupp-road, Stratford, E. 15, which is to be called the "Broadway" Exchange. The exchange, which is a temporary one designed to relieve the "Stratford" exchange area, started with the transfer of 225 subscribers' lines from that exchange. Sufficient equipment is provided to meet the anticipated development in the district pending the building of a large new exchange. "Broadway" is the second new exchange opened since the New Year for the relief of existing exchanges, the first being "Latchmere," in the Battersea area, which was brought into operation last month, and a third exchange, the "Clerkenwell," is nearing completion.

Miscellaneous.

The recommendation of Council of the Senate of Cambridge University that a Professorship of Physical Chemistry should be established has been approved.

An employee, named Hill, at the L.C.C. tramway sub-station at Upper-street, Islington, received a fatal electric shock on Sunday morning. The inquest has been adjourned for technical evidence.

The Ediswan Staff Association are carrying out an attractive programme of social events during the winter season at Ponders End Works, and one of these gatherings held last Saturday evening proved extremely enjoyable. About 100 members sat down to dinner in the staff café, Mr. C. E. Hiatt presiding. Subsequently a concert was provided and was largely attended, Mr. F. H. Holyday officiating as musical director. The recently organised pierrot troupe, recruited from the ranks of the staff, made their initial appearance in public and gave an extremely creditable performance of choruses, duets, solos, &c.

At Hull Police Court last week George H. King, tradesman, and George A. Lamb, secretary, were charged with unlawfully laying electric mains and making connections with the supply mains of the Corporation. Major H. Bell, City Electrical Engineer, gave evidence, and said there were the most urgent reasons why those connections should not be made without the knowledge of the Corporation. In the case of King, he had a knowledge of electricity, and he utilised an overhead telephone wire from one of his shops to another to convey the current, and it was explained that it was dangerous to use telephone wire for supplying current for lighting. In the other case, defendant fixed up a cable for outdoor lighting. In both cases the current was registered through meters, and there was no question of the current not having been paid for. Each defendant was fined £2 2s.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country during January, 1920, with increase or decrease compared with January, 1919:

Electrical machinery, £109,001 (increase £87,938); telegraph and telephone cables, other than submarine, £1,174 (decrease £683); telegraph and telephone apparatus, £8,399 (decrease £3,500); other electrical wires and cables, rubber insulated, £1,914 (increase £1,914); with other insulations, £1,886 (increase £1,260); carbons, £16,605 (increase £13,659); glow lamps, £4,117 (decrease £18,260): arc lamps and electric searchlights, £120 (increase £120); parts of arc lamps and searchlights (other than carbons), £2,498 (decrease £8,416); batteries, £1,544 (decrease £5,145); meters and measuring instruments, £4,051 (increase £1,440); switchboards, £956 (increase £742); electrical goods and apparatus unenumerated, £34,605 (increase £18,499). Total of electrical goods and apparatus, £77,869 (increase £1,640).

Exports.—The exports of electrical machinery, material, &c., during January, 1920, with increase of decrease compared with January, 1919, were as follows:—

Electrical machinery, £173,926 (increase £70,061), including railway and tramway motors, £2,911 (decrease £6,588); other generators and motors, £108,187 (increase £61,164); other electrical machinery, £62,828 (increase £15,485); telegraph and telephone cables, submarine, £81,323 (increase, £59,792); other than submarine, £76,835 (increase £50,029); telegraph and telephone apparatus, £98,756 (increase £75,094); other electrical wires and cables, rubber insulated, £112,574 (increase £93,252); with other insulation, £137,532 (increase £118,104); carbons, £2,322 (increase £2,133); glow lamps, £10,495 (increase £1,350); arc lamps and searchlights, £432 (decrease £2,223); parts of arc lamps and searchlights (other than carbons), £295 (decrease £2,405); batteries, £35,829 (decrease £17,238); meters and measuring instruments, £20,647 (increase £3,039); switchboards, £12,047 (increase £9,266); electrical goods and apparatus unenumerated, £101,296 (increase £13,895). Total of electrical goods and apparatus, £690,394 (increase £404,049).

Tenders Invited and Accepted.

York Electricity and Tramways Committee invite tenders by noon Feb. 27 for a 3,000 kw. turbo-alternator, condensing plant, three water-tube boilers, mechanical stokers, &c.

Salford Electricity Committee want tender for two water-tube boilers, mechanical draught plant, &c. Tenders to the Chairman by the 23rd inst.

Aylesbury Corporation require tenders by noon March 10 for the supply and fixing of two electric motors and pumps at the sewage works. Specifications can be seen at the office of the Borough Engineer.

Barrow in Furnace Corporation require tenders by noon March 8 for the supply of electrical stores, meters, joint boxes, &c. Forms of tender from the Borough Electrical Engineer.

Sydney (N.S.W.) Council require tenders by 3 p.m., March 1, for the supply of two 2,000 p.v.a., 5,000-10,000 volt transformers (contract No. 571). Specifications from the City Electrical Engineer.

The directors of the Bedwas Navigation Colliery Company, Ltd., Bedwas, Mon., require tenders by 10 a.m., March 4, for six months' supply of stores, including electrical goods, ironmongery, oils, &c.

The Commissioners of H.M. Works require tenders by 11 a.m. Feb. 26, for 12 months' suply of fusebands, switches, &c. Forms of tender from the Controller of Supplies, King Charles-street, Westminster, S.W.1.

Dublin Tuberculosis Committee of Management, 3, Cork-hill, Dublin, require tenders by noon Feb. 26 for the supply and erection at Crooksling Sanatorium, Brittas, Co. Dublin, of an electrically-driven triple ram water pump.

The City of Melbourne invites tenders for the supply of 12,000 metal filament lamps. Specifications, &c., from the agents of the City Council, Messrs. McIlwraith, McEacharn & Company Ppty., Ltd., Billiter-square-buildings, London, E.C. 3, to whom tenders are to be sent by noon March 30.

Aberdare Urban Council invite tenders for one year's supply of stores for the electricity and tramways departments, including cables, meters, joint boxes, electric lamps, ironmongery, parts, &c. Forms from the general manager and tenders to the clerk (Mr. W. R. Morgan), Town Hall, Aberdare, by March 8.

The Electrical Committee of Bristol Corporation invite tenders for the supply and erection of one 2,000-kw. single-phase 2,200 volt turbo-generator, with condenser and auxiliaries. Specifications and forms of tender from the chief engineer and general manager, Mr. H. Faraday Proctor, M.I.C.E., to whom tenders by the 23rd inst.

The Tramways Committee of the Manchester Corporation invite tenders for the supply of tramway stores and materials, including motor and controller parts, resistances, armature and field coils, trolley poles, lamps, bells, insulation material, carbon brushes, overhead equipment, meters, cable, &c. Schedules from the general manager, and tenders to the Chairman of the Committee, 55, Piccadilly, Manchester, by Feb. 24.

The Great Central Railway Company invite tenders for 12 months' supply of various stores and materials, including electric line construction material and apparatus, wires and cables, casing, accessories and lamps, globes and shades, hardware, indiarubber, wire, signal materials, &c. Specifications from Mr. Walter Williams, stores superintendent, Gorton, Manchester, and tenders to the secretary, Mr. J. A. Campbell, Marylebone Station, London, N.W., by March 17.

Lincoln Corporation invite tenders for the supply and erection of an accumulator battery at St. Swithin's power station. Specifications from the consulting engineers (Messrs. Preece, Cardew & Rider), 8, Queen Anne's-gate, Westminster, S.W.1; and specifications can also be seen at the office of the city electrical engineer, Mr. Stanley Clegg. Tenders, on forms to be obtained from the Town Clerk's office, Guildhall, Lincoln, by March 2.

Hammersmith (London) Borough Council invite tenders for the supply of electricity stores, including electric light sundries, fire bricks, insulated wire, cable ducts, joint boxes, meters, cable compound, engineering tools, steam packing, &c. Forms from the borough electrical engineer, Mr. G. G. Bell, and tenders to the Town Clerk (Mr. Leslie Gordon), Town Hall, Hammersmith, W.6, by 4 p.m., March 3.

Belfast Electricity Committee invite tenders for various stores and materials, including mill furnishings, packing and asbestos goods, lubricating oils, tools, cables, wires, electrical accessories, lamps, carbons, brushes, bitumen, tapes, joint box compounds, fuses, wood and stoneware troughing, conduits, c.-i. and w.-i. pipes, feeder and suction pillars, meters, &c. Forms of tender from the City electrical engineer, Mr. T. W. Bloxam, and tenders must be lodged at the office of the Town Clerk (Mr. R. Meyer), City Hall, Belfast, by March 10.

Doncaster Corporation has accepted tenders for erecting a new tramcar shed at £7,983) and for raising the level of part of the track of the Bentley route at £27,990.

Sunderland Corporation has accepted the following tenders on behalf of the Electricity Committee: Reesoils, Ltd., transformer oil; Ferguson Pailin, Ltd., H. T. switchgear; and Ferranti, Ltd., meters.

Burnley Corporation has accepted the tender of the British Thomson-Houston Company for five tramcar electrical equipments at £803 5s. each, and that of the Brush Company for five single-deck bodies at £1,350 each. The tramways department will construct the trucks at an estimated cost of £1,060 each.

Institution Notes.

RÖNTGEN SOCIETY.—The title of the Silvanus Thompson Memorial Lecture, to be delivered on March 2, by Prof. W. H. Bragg, C.B.E., F.R.S., is "Analysis by X-Rays."

THE INSTITUTION OF ELECTRICAL ENGINEERS. The annual dinner will be held at the Connaught Rooms, Great Queen-street, W.C., on Thursday, March 4, 1920. Application for tickets should be made to the Secretary, 1, Albemarle-street, London, W. 1, not later than Saturday, Feb. 28.

The current issue of the "Journal" of the INSTITUTE OF METALS contains an account of the ninth May Lecture which was delivered by Prof. F. Soddy, F.R.S., on "Radio-Activity." It also contains a full account of the communications and discussion at the recent Sheffield meeting of the Institute.

At the February meeting of the DIESEL ENGINE USERS' ASSOCIATION Mr. Geoffrey Porter read a Paper on the "Wear of Diesel Engines." This contained a large amount of useful data as a result of observations and measurements taken by the author over long periods on engines under working conditions. The author particularly called attention to the deleterious effect of excessive cylinder lubrication, while questions in connection with the wear of pistons, piston rings, air compressor parts and crank shafts were also carefully considered.

The inaugural meeting of the SOCIETY OF ENGINEERS (Incorporated) was held on the 9th inst., in the apartments of the Geological Society, Burlington House, when Mr. Burnard Geen, President for 1920, delivered his address. After dealing with the work and utility of the society and the education and training of engineers, the President dealt with his main theme, "A few aspects of the present position of engineering." The premiums awarded for Papers delivered during 1919 were presented: President's Gold Medal to Mr. A. S. E. Ackermann, B.Sc. (Eng.); Bessemer Premium to Mr. C. O. Bannister, F.I.C.; Nursey Premium to Prof. James Young, and Society's Premium to Capt. N. E. de Jarny.

Speaking at the annual dinner of the Midland Section of the JUNIOR INSTITUTION OF ENGINEERS, Prof. Burstall said that civilisation before 1900 had its roots embedded in coal. Since that time civilisation had depended more and more upon art. Our art production was comparatively small, while our production of coal was large. There existed other portions of the world where the conditions were the reverse and we must contemplate the fact that these favoured regions would develop at the expense of the more worn-out civilisation. The future would be especially one in which scientific truths would be applied to the necessities of mankind, and engineering would loom larger and larger. It was recognised that competition had about reached its limits.

Business Items, &c.

The offices of the Light Railway Commission have been removed to 7, Whitehall-gardens, S.W. 1.

At the end of the month Erith's Engineering Company, Ltd., are removing to their new offices at Windsor House, 83, Kingsway, London, W.C. 2.

Wm. A. and L. O. Heyes (trading as Heyes & Company), electrical engineers, Douglas Side, Wigan, have dissolved partnership. Debts by Mr. W. A. Heyes, who continues the business.

Catalogues of British machinery and plant manufacturers are wanted by the National Industrial Corporation of Africa, National Bank-buildings, 85, Commissioner-street, Johannesburg.

Messrs. Everitt & Company, 40, Chapel-street, Liverpool, have for family reasons converted their business into a private limited liability company, under the title of Everitt & Company, Ltd. The change will not affect the conduct or management of the business, which will remain as heretofore.

We are informed that owing to the increase of business Messrs. Fuller's United Electric Works, Ltd., have been obliged to transfer their sales department from Chadwell Heath to Iddesleigh House, Caxton-street, Westminster, S.W.1. Telephone: Victoria 6,863-4; telegrams: Blocbat Vic, London. The company will shortly open a show room at the new premises, where their various products will be on view.

It has been decided to reconstruct the Engine Development Company, Ltd., which owns the British patent rights and has been carrying out the development and research work on the Still engine. The Still Engine Company, Ltd., has been formed with a capital of £300,000 in £1 shares, to take over the whole of the rights in the Still engine for the world, excluding Japan. An issue of 75,000 shares is being made at par for providing working capital, &c.

Liquidations.

A meeting will be held on March 6, at 4, Cathedral-road, Cardiff, to receive an account of the winding up of the Rhymney Valley and General Electric Supply Company, Ltd. (in vol. liq.).

The Rex Accumulator Company, Ltd., is being wound up voluntarily and Mr. Malcolm Leggett, Dashwood House, 9, New Broad-street, London, E.C., has been appointed liquidator.

The Mexborough & Rawmarsh Construction Syndicate, Ltd., is being wound up voluntarily and Mr. L. B. Schlesinger and Mr. Wm. B. Cownie have been appointed liquidators. A meeting of creditors will be held at 62 and 63, Queen-street, E.C. 4, on Feb. 27, and claims are to be sent to the Liquidators at that address.

Personal and Appointments.

Mr. Hubert Baines, O.B.E., has been appointed chief engineer to H.M. Office of Works, in succession to Mr. H. A. McFerran, O.B.E., who has retired.

Mr. Bernard Sankey, M.I.E.E., engineer of the Port Elizabeth Tramway Company, has been appointed general manager of the electric supply and gas departments of Johannesburg Corporation.

Mr. N. B. Rosher, O.B.E., M.I.E.E., has resigned his appointment with the Ministry of Munitions in order to rejoin his firm, Messrs Moffett & Rosher, consulting and inspecting engineers, 63, Temple-row, Birmingham.

Mr. E. T. Goslin, M.I.E.E., M.Am.I.E.E., chief electrical engineer to the Glasgow Corporation tramways, has been appointed general manager of the Clyde Valley Electrical Power Company, in succession to Mr. Archibald Page, who has been appointed one of the Electricity Commissioners. Mr. Goslin joined the tramways department in 1900 as assistant engineer, and succeeded Mr. M. B. Field as chief engineer some 18 years later. Previous to his Glasgow appointment, Mr. Goslin was with the County of London Electric Supply Company, the Hove Electric Lighting Company and Messrs. Crompton & Company. During the war Mr. Goslin was lent to the Coal Controller, and was afterwards appointed Deputy Director of Labour for the West of Scotland. The Company of Royal Engineers (V.), raised by the Scottish Section of the I.E.E., was commanded by Major Goslin.

MR. E. T. GOSLIN.

Catalogues, Price Lists, &c.

In a four page pamphlet issued by the Cressall Manufacturing Company, Staniforth-street, Birmingham, particulars and prices are given of "Cressall" electric kettles.

A number of publications have been issued by the STERLING TELEPHONE & ELECTRIC COMPANY, LTD., 210-212, Tottenham Court-road, London, W., which give illustrated particulars and prices of some of the Company's manufactures. A four-page pamphlet is devoted to "Sterling" mining telephones, another four-page publication deals with the Sterling shaft signals, a leaflet gives particulars of Sterling (ferro-case) telephones, while the others relate to accumulators, bells and "Gripit" indicators respectively. The whole of the Company's manufactures are British made.

List W of Mr. H. W. Sullivan's standard condensers and wireless apparatus is now ready and may be obtained on application from 368-9, Winchester House, Old Broad-street, London, E.C.2. The first section of the catalogue, which is well illustrated, is devoted to laboratory standards, and the second deals with wireless apparatus. Prices, dimensions and other particulars of the various instruments and pieces of apparatus are included.

Obituary.

We regret to record the death of Mr. CHARLES MARK DORMAN, Managing director of Messrs. Dorman & Smith, Ltd., manufacturing electrical engineers of Salford. Mr. Dorman, who passed away suddenly at Llandudno on the 12th inst., lost his son in the war in the autumn of 1917, and he never quite recovered from that shock. We learn that he showed signs of illness just before Christmas, and his heart was causing anxiety to his friends. It was hoped that a few weeks' holiday at Llandudno would have been beneficial. Unfortunately his condition became very serious whilst staying at Llandudno, until he became too ill to be moved. We need scarcely remind our readers of Mr. Dorman's position as a pioneer in electrical work, and some of the switchgear designs originated by him in the eighties are still good practice at the present time.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

113,096 Bosch Akt-Ges. Device for regulating the voltage of current generated by a dynamo. (26/1/17.)

The armature of an electromagnet influenced by the factor to be regulated operates two contacts so arranged that the exciting winding is periodically inserted by one contact and periodically short-circuited by the other contact, and in which when the armature is between both contacts a winding is inserted in series with but in opposition to the main winding.

135,818 Elektro-Osmose Akt.-Ges. (Graf Schwerin Ges.) Apparatus for electro-osmotically removing liquids from materials. (20/10/17.)
135,819 Elektro-Osmose Akt.-Ges. (Graf Schwerin Ges.) Apparatus for electro-osmotically removing liquids from materials. (20/10/17.)
135,820 Elektro-Osmose Akt.-Ges. (Graf Schwerin Ges.) Apparatus for electro-osmotically removing water. (20/10/17.)
136,198 Sordi. Electric liquid heating apparatus. ([illegible] 8/18.)
136,202 B. T.-H. Co. & Taylor. Dynamo-electric machines. (30/8/18.)
136,203 Tower. Electrical system for generating intermittent high-tension current impulses for ignition purposes, with or without low-tension current for battery charging, lighting and the like. (10/9/18.)
136,207 Cross. (Hulfish.) Automatic telephone systems. (11/10/18.)
136,211 Magini & Bassanese. Arrangement for evenly distributing single-phase loads between the phases of a polyphase supply system. (6/11/18.)
136,215 British Lighting & Ignition Co. & Turner. Armature windings of electric alternating-current machines. (14/11/18.)
136,220 Stanneford. Continuous feed for arc lamps. (4/12/18.)
136,240 Siemens Bros. & Co. & Ferreira. Armatures and pole shoes of magnets. (7/12/18.)
136,260 Parker & Smith. Trolley heads for electric traction. (11/12/18.)
136,268 Cable Accessories Co., Reeves & Crawford. Casings or boxes for electrical fuses and other such apparatus. (12/12/18.)

1919 Specifications.

122,828 Armour Fertilizer Works. Electric furnaces. (28/1/'19.)
126,947 Hartmann. Apparatus for producing a continuous electrically conducting liquid jet. (11/5/18.)
132,518 Mauron. Automatic voltage regulation of variable speed dynamos. (10/9/18.)
136,002 Woods. Electrical earthing devices. (11/1/19.)
136,006 Railing, Farthing & Levee. Combined electric switches and plug connectors (17/1/19.)
136,016 Quasi-Arc Co. & Stronmenger. Variable resistances particularly adapted for use in electric welding. (29/1/19.)
136,026 Cooke. Storage batteries for electricity. (7/2/19.)
136,029 Gormly. Carrier for the shades of electric lamps. (10/2/19.)
136,034 Moore. Electric arc furnaces. (13/2/19.)
136,059 Jackson-Mellersh. (Taylor.) Radio-telegraphic transmission systems. (25/3/'19.)

Consists of a combination comprising a source of oscillations, a radiating circuit connected to said source, an oscillatory circuit shunted around said source, the two circuits being of such relation to each other that the oscillations will prefer one circuit to the total neglect of the other; means in the oscillatory circuit for producing hysteresis losses and means for varying said losses to cause the oscillations to prefer the other circuit.

136,320 Wade. (Buckley.) Fuse-replacing appliances for electric circuits. (2/1/19.)
136,340 Edgeworth. Telephone repeater systems. (20/1/19.)
136,359 Cohen. Telephonic transmitters. (29/1/19.)
136,367 Coates & Metropolitan Vickers Electrical Co. Electric fuses. (5/2/19.)
136,373 Stirk, Stirk & Stirk. Control of electric motors driving reciprocating machines such as planes and the like. (6/2/'19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

October 17, 1919

25,454 Swinburne. High-frequency generator.
25,456 Taylor. Distribution in alternating-current systems.
25,466 Callender's Cable, &c., Co. Jointing metallic sheathed cables.
25,467 Callender's Cable, &c., Co. & Moor. Spring contacts for switch or switch-fuse handles.
25,474 Hobley & Hooper. Electrical indicating apparatus for transmission of orders, &c.
25,475 Cosway. Hot-plates, &c.
25,485 Metropolitan-Vickers Electrical Co. Balancing of polyphase systems.
25,487 Attwater. Insulation, &c., of live rails, &c.
25,497 Cowper-Coles. Zinc battery elements.
25,505 Willard. Paste for battery heaters.
25,509 Dahl. Commutators. (16/10/'18, Denmark.)
25,518 Clifford of Chudleigh (Baron). Dynamo-electric machines.

October 18, 1919.

25,553 Rylands Bros. & Atkins. Metal electrodes for welding, &c.
25,558 Harrison. Electric furnaces.
25,559 Schroeder. Dynamo-electric machines.
25,560 Automatic Telephone Mfg. Co. & Smith. Electromagnetic mechanisms for telegraph purposes, &c.
25,563 Rhind. Electric hand lamps.
25,566 Woods. Wiring systems.
25,579 Sebline. Conversion of alternating current into continuous current or of continuous current into continuous current of different tension. (19/10/18, France.)
25,581 Mann & Purden. Electric motors.
25,598 Cardellino. Magneto-electric machines.
25,609 Tomkins. Stampings for electric machines.

October 20.

25,646 Blaiberg. Starting electric generators driven by internal combustion engines, &c
25,654 Meyer & Robinson. Telephone transmitter mouthpiece.
25,661 Automatic Telephone Manufacturing Company & Harrison. Signalling arrangements for telegraphs, telephones, &c.
25,669 Mangles & Pritchard. Telephone transmitters.
25,703 Sayer. Plough or current collector for conduit tramways.
25,712 Beyer. Electro-magnetic clutches. (14/3/19, Germany.)

October 21.

25,718 and 25,719 Sebline. Conversion of a.c. into c.c. and inversely, or of c.c. into c.c. of different tensions.
25,722 Dean & Redmayne. Electrical fuses and distribution boards.
25,739 Parrott. Electrical starting devices for engines.
25,756 Crabtree & Tucker. Electrical switches.
25,781 Gush. Insulators for electrolytic systems of protection against corrosion of submerged metallic surfaces.
25,802 Botey, Guerra & Codornia. Combined electrical interrupters and switches.
25,815 B.T.H. Company (G.E. Company). Controllers for electric motors.
25,817 Codd. Electric ignition systems for internal combusiton engines.
25,826 Metropolitan Vickers Electrical Co. Air-cooling apparatus.

Companies' Reports, &c.

Messrs. Mather & Platt, Ltd., have declared a dividend of 10 per cent. (tax free) on 1,050,000 ordinary shares.

The directors of the Chloride Electrical Storage Company, Ltd., propose to capitalise £73,250 of reserves and utilise that amount in distributing new ordinary shares of £1 each to holders in the proportion of one new share to every two now held.

The report of the City and South London Railway Company for 1919 states that the total net income was £144,486, and the balance from 1918 was £24,567. After paying interest and other fixed charges, appropriating £25,000 to reserve, and paying the dividends on the preference stocks the available balance is £54,350. It is proposed to pay a final dividend of one per cent. on the consolidated ordinary stock, making with the interim dividend of one per cent., two per cent. for the year (as in 1918), to place a further £5,000 to reserve (making £30,000 for the year) and to carry forward £19,750, against £24,567.

For the year ended Sept. 30 last the net profit of Mann, Egerton & Company, Ltd., after meeting debenture interest and providing for depreciation, &c., was £56,170. Adding sum brought forward and deducting interim preference dividend the total is £64,302. The directors recommend a dividend of 10 per cent. on the ordinary shares, carrying forward (subject to excess profits duty) £48,684. The share capital has recently been reorganised and the company has been converted from a private to a public company. Additional ordinary shares to the amount of £30,000 were issued as a bonus out of the reserves and an issue of 8 per cent. cumulative preference shares was also made.

The report of the British Columbia Electric Railway Company for the year ended June 30 last states that provision for depreciation, sinking fund and renewals required £154,727; addition to capital amortisation fund, £1,818, leaving a net revenue of £224,601, to which is added profit on exchange and moneys formerly set aside for contingencies and no longer required (£138,419) and £6,085 brought forward, making a total of £369,105. Out of a balance of £128,658 the directors recommend payment of a final dividend on the preferred ordinary stock of 2½ per cent. (making 5 per cent. for year), a dividend on the deferred ordinary stock of 3 per cent., together with a bonus of 3 per cent. on the deferred stock, leaving £6,258 to be carried forward.

The gross receipts of the Metropolitan District Railway Company for 1919 were £1,565,568 and the total net income was £565,611 (against £585,703). After meeting interest and fixed charges, placing £45,000 to reserve and paying the dividends on the guaranteed and first preference stocks, the balance is £80,898 (a decrease of £23,933). A final dividend of 1½ per cent. is recommended on the second preference stock, making 4 per cent. for year (against 5 per cent.) and £22,098 is carried forward (against £21,332). Orders have been placed for a large number of additional carriages of an improved type. The company, with its associated companies, is promoting a Bill for authority to increase the maximum powers of charge.

An extraordinary general meeting of the General Electric Company, Ltd., was held on Saturday, when resolutions were passed providing that the 1,655,790 issued preference shares and 144,210 of the unissued preference shares be called A preference shares and that the remaining 1,800,000 preference shares unissued be converted into seven-and-a-half per cent. B cumulative preference shares. The chairman (Mr. H. Hirst) reminded the shareholders that at the last annual meeting the board's programme of developments was outlined and the capital increased from £3,000,000 to £6,000,000. In carrying out that programme considerable progress with new works had been made, with the assistance of their bankers. It was now thought desirable to make an issue of further capital, which, it was contemplated, would take the form of seven-and-a-half per cent. B cumulative preference shares and some ordinary shares, but the actual amount and terms of issue had not been settled.

The net profit of the Electrical Distribution of Yorkshire, Ltd., for 1919 was £4,354, against £3,168 in 1918. With bmount brought forward (£886) the available balance is £5,240. The directors recommend payment of a dividend (tax free) at the rate of 6 per cent. per annum on the ordinary shares (£2,962), adding £1,000 to reserve fund, and carrying forward £1,279. Restrictions on the use of electricity were not completely withdrawn until the latter part of the year, and, due to industrial disturbances throughout the country, the delivery of material was greatly delayed, thus retarding the growth of the company's business. Applications for supply have been received in large numbers, and with the restoration of normal industrial conditions a rapid expansion of business is assured. This expansion will require further capital.

Lord Aberconway, who presided over the meeting of the Metropolitan Railway Company last week gave particulars of the receipts and expenditure during the past year. The results of the Great Northern and City line had more than justified the policy of the company in acquiring that undertaking. The traffic receipts from the line for the last year before they took it over were £74,000, but in 1919 they had increased to £132,000. The Metropolitan Railway Country Estates, Ltd., had purchased a large estate between Chorley Wood and Rickmansworth, another between Neasden and Wembley, and also some land in Kingsbury, with a view to their development as building estates. The railway would reap very considerable benefit from those operations. After dealing with the question of Government control and with the necessity for an increase in fares, he said that the traffic, not only on that line, but on the other London lines, had already outgrown the facilities, and the immediate expenditure of large amount of capital, but things were and would remain in a somewhat uncertain state until the policy of the Government and of the Ministry of Transport was made known.

The revenue of the Lanarkshire Tramways Company for 1919 amounted to £199,868, and the expenses to £148,060. After meeting contributions payable to local authorities, interest on debentures, &c., and transferring £12,000 to depreciation and £5,000 to maintenance reserve, and adding amount brought forward (£5,912), the balance is £31,888. Of this sum £12,005 has been paid for the interim dividend at the rate of 7 per cent. per annum for the half-year ended June, and the directors now recommend a dividend of 8 per cent. per annum for the half-year ended Dec. 31, 1919, making a total dividend of 7½ per cent. for the year. A sum of £882. 11s. 6d. is to be paid to the directors (being 10 per cent. of net profits after payment of 5 per cent. dividend), and this will leave £5,280 to carry forward, subject to excess profits duty. The revenue increased by £7,338 and the expenses by £22,010, compared with 1918. There was also an expenditure of £7,816 on deferred repairs during the year which has been charged against maintenance reserve account. The strike of certain traffic employees in April and May last involved a loss of traffic revenue of £10,000.

The total net income of the London Electric Railway Company for 1919 was £611,601, and adding £23,605 from 1918 the total was £635,206. Interest and other fixed charges absorbed £290,738, and after appropriating £45,000 to reserve and paying the dividend on the preference stock (£126,947), the balance is £172,521. An interim dividend of 1 per cent. was paid in August on the ordinary shares, and the directors now recommend payment of a final dividend on the same shares of ⅝ per cent., making 1⅝ per cent. for the year, leaving £20,942 to be carried forward. The dividend on the ordinary shares for 1918 was two per cent., with £23,605 carried forward. It is stated that orders have been placed for a large number of additional carriages of an improved type. The company and its associates are promoting a Bill for authority to increase the maximum powers of charge. Reference is made to the resumption of Lord Ashfield's connection with the Company as Chairman and Managing Director, and to the appointment of Lord Farrer as Deputy Chairman. Admiral Sir Cyprian A. G. Bridge, G.C.B., and Sir Algernon West, G.C.B., have retired, and Mr. C. J. Cater Scott and Mr. Geo. Watson succeed them. Mr. W. C. Burton, who acted as resident director since 1916, has also resigned on his return to America.

The report of the St. James' & Pall Mall Electric Light Company, Ltd., states that the connections, which at the end of 1918 were 18,114 kw., have been increased to 18,902 kw., and 12,190,175 units were supplied to consumers during the year. The net profit is £35,000 12s. 1d. A sum of £4,576 4s. 4d. was brought forward, and after paying the interim dividends of 7 per cent. on the preference shares (£3,500) and on the ordinary shares (£7,000), the available balance is £29,076 16s. 5d. The directors propose to pay a dividend at rate of 7 per cent. on the preference shares (£3,500) and a dividend on the ordinary shares for the second half-year of 8s. 6d. per share, making, with the interim dividend, 12 per cent. for the year (£17,000), leaving to be carried forward £8,576 16s. 5d. Reference is made to the Electricity (Supply) Act, and it is hoped that by the formation of a Joint Electricity authority arrangements may be put in force whereby the best and most efficient use will be made of the resources and experience of the different undertakers, which will result in electricity being produced and sold at the cheapest possible rate, while at the same time the rights and interests of the shareholders will be duly safeguarded.

The report of the directors of the Westminster Electric Supply Corpn., Ltd., for the year 1919 states that the total power of the lamps, motors and apparatus connected to the mains was equivalent to about 52,457 kw. at Dec. 31, compared with 50,166 in 1918. It is pointed out that the Electricity (Supply) Act enables the different companies and authorities and others in a district to combine to form a joint electricity authority for the district, and the leading London companies have already associated themselves for this purpose. It is hoped that by the formation of such an authority arrangements may be put in force whereby the best and most efficient use will be made of the resources and experience of the different undertakers which will result in electricity being produced and sold at the cheapest possible rate, while at the same time the rights and interests of the shareholders will be duly safeguarded. An interim dividend at the rate of 7 per cent. per annum on the ordinary shares and the dividend on the 4½ per cent. preference shares, for the half-year ended June 30, 1919, have been distributed. After allowing for depreciation, sinking fund and other charges, the balance is £74,144, from which must be deducted the second half-year's dividend on the preference shares, which absorbed £12,375, leaving £61,769. Out of this the Board recommend payment of a dividend at the rate of 13 per cent. per annum (less tax) for the past half-year, making 10 per cent. for the year, carrying forward £15,473.

In the course of his speech to the shareholders of the Melbourne Electric Supply Company, Ltd., at the meeting on Monday, Mr. J. B. Braithwaite said they had made an issue of first cumulative preference shares, and since the close of the year had issued a further £100,000. They were now making an issue of 100,000 ordinary shares, which, when fully paid, would be converted into consolidated ordinary stock. They had thus increased their capital by £300,000 during the year, and as the issue of ordinary shares was being made at 25 per cent. premium, they were really obtaining £325,000 of additional capital. The gross profit for the year was £180,160, compared with £161,887 in the previous year, and they were some £20,000 to the good in the net earnings. After referring to the industrial strife in Australia the chairman said they had had an important increase in their area during the year, due to the new order they had got for the southern portion of Moorabbin. The number of consumers added was 5,560, which was a record number, and 18 per cent. better than that of the previous year. The total number of consumers was 42,430, and, including those taking bulk supply, the figure would be over 51,000, which he believed was larger than that of any other company, certainly in London. With regard to the current year, they were considerably better in net profit compared with the same period last year, and the additions to the number of consumers were going on at an accelerated pace.

The total net income of the Central London Railway Company for 1919 was £186,917, and with £17,484 brought forward the total was £204,407. Deducting interest and fixed charges (£46,039), appropriating £20,000 to reserve and paying the preference stock dividend (£21,600), the balance is £116,762. The interim dividends of 2 per cent. on the ordinary and preferred ordinary stocks absorbed £46,936, and it is now proposed to pay final dividends of 1½ per cent. on the ordinary and 2 per cent. on the preferred ordinary stocks, together with a dividend of 3 per cent. on the deferred ordinary stock, making 3½ per cent. on the ordinary and 4 per cent. on the preferred ordinary stock for the year, leaving to be carried forward £11,762. In 1918 4 per cent. was paid on the three classes of stock. During the year the gross revenue of the five associated companies increased £2,497,018, or 32 per cent., compared with 1918. The operating expenses and interest on guaranteed and preference stocks and reserves increase £2,632,321, or 37 per cent. The amount available for dividends and further reserves decreased £135,303, or 21 per cent. After carefully reviewing the situation, the directors have decided that if sufficient revenue is to be obtained to meet the working expenses, to provide for adequate depreciation and renewals, and to obtain a reasonable return upon the money invested in the undertaking, fares must be increased. The companies concerned have introduced a Joint Bill in Parliament seeking authority to increase their maximum powers of charge.

Yorkshire Electric Power Company.

In moving the adoption of the report and accounts at the meeting of the Yorkshire Electric Power Company on Tuesday, Mr. A. G. Lupton said that the general adoption of a shorter working week in the early part of the year and various labour disputes all had their effect in retarding development. Working costs had been heavy owing to the price of coal and of all stores and wages. The salaries and wages paid in 1913 were 27 per cent. of the total expenditure, but in 1919 they had increased to 40 per cent. The extra costs had been met by the increase of revenue and the directors felt justified in recommending a dividend of 8 per cent. The capital account showed the assets at over one million pounds, but a valuation of the plant would show the present value to be largely in excess of the book figures, owing to the large increase in the cost of machinery and mains. Over one-fifth of the capital had been subscribed by customers and that was a great element of strength. Each additional consumer helped to reduce the cost of production not only to himself but to all others, and it was a satisfaction that all classes of power users were realising the advantages of co-operating through the agency of the company. The Electricity Act recognised and endorsed the principles by which the company had always stood, that of generation in large central stations and distribution throughout large areas, and it was now the duty of the company to respond to the call and take its full share in developing the area committed to it. High costs and the scarcity of labour were rendering manufacturers daily more disposed to devote themselves to their own proper business and to look to their company to provide their motive power as and when required. As a consequence, demands for current were pressing on them from every side and fully justified the large extensions. Not only was the demand for power increasing more rapidly, but the smaller electricity supply undertakings were deciding to purchase in bulk from the company rather than to continue to generate electricity in small and relatively inefficient stations. Out of the 55 undertakings in their area arrangements had been made in 41 cases for bulk supply or joint working so that the unification of supply over the whole of their area was within measurable distance of completion. Arrangements had been made for bulk supply to the Corporations of Batley, Dewsbury, Todmorden and Wakefield. Agreements had also been made with some of the larger municipalities for interchange of supply in the spirit of the Coal Conservation report, and they hoped to carry those ideas a good deal further.

The company had now nearly 400 miles of mains bringing in good revenue and the time had come when the company must take another great step forward. They therefore asked them to consolidate the company's finance by authorising an issue of debentures to repay loans from bankers and the Government, which had been spent on plant and mains already earning good revenue, and to take part in the issue of further ordinary shares to enable them to meet the large demands. The development of the new station at Ferrybridge had been held up. The station was urgently required and it was grievous that so much delay had been forced upon them by legislative uncertainties and that it was only now possible to go forward with the preparation of plans when complete. The plans would require considerable additions of capital, but the funds for which they now asked would enable extensions to be made and would widen the basis of the Company, and enable it to carry on and to earn revenue which would justify the further advances as they became necessary. It had been a satisfaction that by the energy and devotion of their engineer and manager (Mr. Woodhouse) and his competent staff, the company had again been able to meet all demands from consumers through a very difficult year; their customers had run full time without anxiety, in contrast to many private concerns in constant dread of being held up for want of coal.

New Companies.

BRITISH GENERATOR COMPANY, LTD. (163,515).—Private company. Reg. Jan. 30, capital £5,000 in £1 shares, to take over the business of an electrical and mechanical engineer, carried on as W. A. Hymas & Company, together with the rights of the vendor in an invention for an electric lighting apparatus. First directors are: W. A. Hymas and J. S. Mills. Reg. office: 481, Oxford-road, Reading.

I. CALVETE, LTD. (163,036)—Private company. Reg. Jan. 20, capital £10,000 in £1 shares, to take over the interest and goodwill of I. Calvete and L. N. Viola in the business of contractors, electrical and mechanical engineers, manufacturers of electrical apparatus, &c., carried on by them. First directors are L. N. Viola and I. Calvete. Reg. office: 11, Little-street, Andrew-street, St. Martin's-lane, E.C.

CHASE ELECTRICAL MANUFACTURING COMPANY, LTD. (163,778)—Private company. Reg. Feb. 6, capital £6,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical appliances, apparatus and fittings, &c. F. Chase is first director. Reg. office: 195, Archway-road, Highgate, London, N.

COWLISHAW, WALKER & COMPANY (1920), LTD. (163,075).—Reg. Jan. 21, capital £150,000 in £1 shares, to take over the business carried on at Etruria, Staffs., by Cowlishaw, Walker & Company, Ltd., and to carry on the business of manufacturers of and dealers in engines, boilers, colliery plant, pumps, hoists, cranes, electrical appliances, &c. Directors are: E. W. Haig, F. W. Poynor, W. A. Hunter and J. A. Edmondson. Reg. office: 14-16, Cockspur-street, S.W.

JOHN OGILVY & COMPANY, LTD. (10,921).—Private company. Reg. in Edinburgh, Jan. 26, capital £20,000 in £1 shares (10,000 preferred and 10,000 deferred), to acquire and take over the business of an electrical contractor lately carried on by J. D. B. Ogilvy at Inshiwan, Forfarshire, and to carry on the business of electrical engineers and contractors, consulting engineers, &c. First directors are W. Anderson and J. D. B. Ogilvy. Reg. office: 48, Queen-street, Edinburgh.

T. C. SMITH, LTD. (10,917).—Private company. Reg. in Edinburgh, Jan. 23, capital £50,000 in £1 shares, to acquire from J. Duncan the business carried on by him as a motor and electrical engineer, &c., as T. C. Smith & Company. First directors are: J. Duncan, E. Milne and R. Watt. Reg. office: 21, Bonaccord-street, Aberdeen.

STANLEY PAVIER MOTOR COMPANY, LTD. (163,506).—Private company. Reg. Jan. 30, capital £2,000 in £1 shares, to carry on the business of motor and electrical engineers, &c. First directors are D. Stanley, E. J. C. Pavier and G. A. Gale. Reg. office: 480, Fulham-road, Walham Green, S.W

STOVES, LTD. (163,567).—Private company. Reg. Jan. 31, capital £20,000 in £1 shares, to carry on the business of ironfounders, electrial and general engineers, manufacturers of stoves, &c. First directors are J. J. Allender, M. Callender, P. Oakley and W. H. Richardson.

SYKES & SUGDEN, LTD. (163,688).—Private company. Reg. Feb. 4, capital £75,000 in £1 shares, to take over the business of motor engineers and body makers, electrical engineers, &c., carried on by Sykes & Sugden, Ltd., at Huddersfield and elsewhere. First directors are A. Sugden, F. Sykes, J. H. Hanson and G. C. Hirst. Reg. office: George-street, Huddersfield, Yorks.

Prices of Metals, Chemicals, &c.

Tuesday, Feb. 17.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£128 0 0	—	£0 10 0
Electro Wirebars...	..	£130 0 0	—	£2 0 0
H.C. wire basis......	per lb.	1s. 5$\frac{5}{16}$d.	—	$\frac{1}{4}$d.
Sheet	,,	1s. 6$\frac{9}{16}$d.	$\frac{1}{16}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 9$\frac{5}{16}$d.	—	$\frac{1}{4}$d.
Brass 60/40—				
Rod, basis	,,	1s. 1d	—	$\frac{1}{8}$d.
Sheet, basis	,,	1s. 5d	$\frac{1}{4}$d.	—
Wire, basis	,,	1s. 4$\frac{1}{2}$d.	$\frac{1}{4}$d.	—
Iron—				
Cleveland Warrants	per ton	£9 2 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£39 0 0	—	—
Lead Pig—				
English	,,	51 10 0	£1 5 0	—
Foreign or colonial	,,	50 10 0	£0 12 6	—
Tin—Ingot	..	389 10 0		£3 5 0
Wire, basis	per lb.	0 4 10	—	—

Salammoniac.—Per cwt. 95s. and 90s.

Sulphur (Flowers).—Per ton £22.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £50.

Boric Acid (Crystals)—Per ton £74

Carbon Bisulphide.—Per ton £56.

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate—Per lb. 6d

Rubber.—Para fine, 2s. 7d.; plantation 1st. latex 2s. 8$\frac{1}{4}$d. to 2s. 7$\frac{1}{2}$d. lb

Shellac.—T.N. Orange, 840s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd.

Thirty-Seven Years Ago.

[From The Electrician, Feb. 17, 1883.]

The Morse Slip (from the Leader).—The announcement we made in our last issue that the postal telegraph authorities of this country had discontinued the practice of preserving Morse slip will be received with surprise in many quarters, but with satisfaction in nearly all. There are still, no doubt, a number of well-meaning officers, both at home and abroad, whose prejudices will be greatly shocked at the step now taken by the British Post Office, and will regard it as little short of a death blow to all discipline. Others who are differently situated, especially those in America, will learn for the first time, and with considerable astonishment, that in England the Morse slip until now has been preserved. To the operating staff generally the announcement that in future the Morse and Wheatstone slip "need not" be preserved after transcription will be good tidings indeed, to which it was hardly necessary to add that said Morse slip "should at once be treated as waste paper."

A description of the lighting of H.M.S. "Himalaya" is given, from which the following extract is made: "The lamps used are of two kinds viz., 20 c.p. lamps and 10 c.p. lamps. There are 171 of the former and 78 of the latter giving a total of 249 lights. The 20 c.p. lamp, to give its normal light, requires a current of about 1·24 amperes, with an E.M.F. of 54 volts. These lamps are all arranged in multiple arc, but the 10 c.p. lamps are placed two in series and in multiple arc, two of the latter being equivalent to one of the former. The arrangements were carried out by Mr. J. F. Albright, of the Swan Company. The lamps have been distributed throughout the ship in the manner shown in the illustration on page 321. The lamps are arranged on seven circuits, all of which are controlled from a main switchboard placed in the electrical room. A detailed sketch of the switchboard is shown at the upper left-hand corner of the illustration.

Abandonment of a Provisional Order.—The Pilsen, Joel & General Electric Lighting Company have withdrawn their application for a provisional order, deposited with the Board of Trade under the Electric Lighting Act, with regard to the City.

Ayrton and Perry's Experiments with Platinum and Magnesium.—Writing on the subject of Profs. Ayrton and Perry's experiments with platinum and magnesium strips dipping into mercury, whereby they obtained a current, M. B. J. Goossens shows in the "Annales Phys. Chem.," that the current thus obtained is caused by the evolution of heat in the formation of the magnesium amalgam, and is, therefore, a thermo-current.

Gas in Paris and London.—In a recent lecture delivered by M. H. Aerts, manager of the Brussels Municipal Gas Works, the following comparison between Paris and London gas was instituted: "The Paris burner consumes 105 litres, or merely 4 cubic ft. per hour. The London burner consumes 142 litres, or nearly 5 cubic ft. per hour. The illuminating power required in London is 16 candles for 142 litres (5 cubic ft.) of gas. The normal illuminating power of Paris gas, consumed in London burners, corresponds to 15·2 candles.

Electric Railways.—Electric power as a means of traction on railways seems to be gaining ground every day. We have instances at Berlin, some mines in Germany, Portrush (Ireland), and elsewhere. Electric railways are talked of in Switzerland and Vienna, and now we hear that the Chicago Town Council has been memorialised by a Mr. Hannahs on the subject. Mr. Hannahs wants to erect an elevated railway in Chicago, the motive power on which shall be supplied by electricity, whilst the carriages will be lighted by the same agency.

Benn Brothers Journals—Some Features of the Current Issues.

In "Ways and Means" Prof. E. E. Lincoln writes on "United States War Finance and After"; and other articles include "The Position of Holland" and "Profit-Sharing in Three Dimensions: an account of the scheme in operation in the Whitefriars Glass Works."

A special monthly section in "The Gas World" deals with the uses of coal gas for the products of power, and the uses of gas in industry generally.

The chief features of "Aeronautics" are "America and the Unified Air Services," "Bombing the Mahsuds," and "Rigid Airships and their Development," by Squadron-Leader J. E. M. Pritchard.

"Labour Saving in the Foundry" (illustrated) by Joseph Horner, is described in "The Hardware Trade Journal," which also includes contributions entitled "Salesmen and Assistants" and "Hardware in Spain" (illustrated).

Among the special articles in "The Cabinet Maker" are: "How to Cut Loose Covers"; "The Furnishing Industry of Yorkshire"; and "From Aircraft to Furniture Making at Hendon."

The report on "Fruit Pruning Experiments at Malling Research Station" is given in "The Fruit-Grower"; also "Grafting in Commercial Rose Culture," and "The Neglected Orchards of Worcestershire."

Foremost among the articles in "The Chemical Age" is "Colloidal Clay as a Catalyst in Oxidation and Hydrogenation," by J. Gordon Hay, F.I.C., being the results of original experiments in a new application of colloidal clay in the chemical industry. There are also reviews of the latest chemical text books, and special reports of Papers at the sectional meetings of the Society of Chemical Industry.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,180. [Vol. LXXXIV. No. 9.] FRIDAY, FEBRUARY 27, 1920 PRICE SIXPENCE. *By Post, 7d. Abroad, 9d.*

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Notes.

Trade Union Organisers and Strikes.

THE considered judgment of Mr. JUSTICE PETERSON in the case of Hodges *v.* Webb, which is given in our legal column this week, is a careful exposition of the law relating to Trade Unions as modified by the Trades Disputes Act, 1906. From the purely legal standpoint we believe the decision to be sound law and good sense, though we confess we have great sympathy for the plaintiff, and we could wish he had been able to obtain some satisfaction for the moral (but not legal) injury inflicted upon him. The dispute originated in the rivalry of two organisations registered as trade unions. Mr. HODGES, the plaintiff and a foreman electrician in the employment of a well-known firm of electrical contractors, was a member of the National Association of Supervising Electricians, and the defendant, Mr. WEBB, was the London district secretary of the Electrical Trades Union. The Association of which plaintiff was a member was registered in 1918: it had less than 100 members, and it was not recognised by the Trade Union Congress because it was considered to be under the influence of, or to sympathise with, the employers in the electrical industry. Antagonism was carried so far that members of the E.T.U. refused to work with the N.A.S.E. members, and while plaintiff was engaged on work at Watford the defendant, who was accompanied by two delegates of his Union, called upon him and made an unsuccessful attempt to persuade him to join the E.T.U. Thereupon Mr. WEBB told him that he would call out the men under plaintiff and that "they could not return unless he (the plaintiff) was off the job." The result was that Mr. HODGES was dismissed by the firm who employed him and he brought an action to restrain the defendant from wrongfully interfering with, or attempting to interfere with his employment and the right to dispose of his labour as he wished. It was alleged that the defendant used threats to the plaintiff in the course of the interviews which took place between them at Watford, but this allegation was denied and plaintiff did not produce sufficient evidence to satisfy the Judge on the point. There could be no doubt that the acts complained of would be illegal at Common Law and the point was whether, in view of the Trades Disputes Act, of 1906, which it will be remembered was passed to reverse the famous Taff Vale judgment, what the defendant had done was actionable. After full consideration the Judge decided that it was not.

There was a genuine trade dispute and the only question left for decision was whether the defendant had employed unlawful means. As his Lordship pointed out, it would be strange and illogical if workmen, who could lawfully cease work in a body, could not, by an official of their trade union intimate to the employers that they proposed to cease work, and give their reasons for doing so. If the defendant had called a strike without speaking to the plaintiff there would be no cause of action, and as the defendant had merely exercised a statutory right by stating that there would be a strike under certain conditions, the plaintiff's action was dismissed. There will be general sympathy for Mr. HODGES, because defendant's acts seem to be like an attempt to coerce him to join the E.T.U., and because of his refusal to do so he lost his employment. To us it appears to be an infraction of the first principle of liberty—the right to employ one's labour to the best advantage. This natural right now appears to be abridged by the Trades Disputes Act, so we must accept the position for the present. Another point of importance came out in the course of the proceedings, and that is that defendant had received a general authority from his executive to call men off work in the Watford or any other dispute. This is too extensive and too dangerous a power to be entrusted to any man, no matter how cautious or prudent he may be, and we hope that with the development of the Whitley Councils some more suitable means will be evolved for the settlement of industrial or trade disputes which do immense damage not only to the parties concerned but to the whole country.

A Distressing History.

AT the annual meeting of the London Electric Supply Corporation last week, Mr. ROBERT H. BENSON once again recounted the history of the private enterprise which gave London its earliest supply of electricity. It is a tale which has been told before, but it does not make less distressing reading at each re-telling. How Mr. JOSEPH CHAMBERLAIN, fearful of monopoly, successfully imposed so many restrictions that hardly anyone thought it worth while to supply electricity at all, and how thereby a promising industry was handicapped from its birth. How eventually these restrictions were to some extent relaxed and London was parcelled out between 13 competing companies on the principle that such competition would result in a cheap and plentiful supply of electricity. In the event this Kilkenny-cat policy resulted in exactly the reverse of what was intended, and whoever benefited by the arrangement it was certainly neither the companies nor the public.' All this was told by Mr. Benson; but he is still optimistic. The companies in spite of the restrictions under which they worked obtained a certain measure of success, says he, and if those "who reached these results are given a fair chance there is every reason to believe that cheap power and plenty of it is in a fair way to be solved in the London district at last." We certainly hope so, but before that desirable state of affairs is reached certain conditions will have to be fulfilled.

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The London Electricity (Joint Committee), 1920, Ltd.

One of these is a recognition that for electricity supply purposes London is one area, or, if that be thought too large, two closely connected areas, one north and one south of the Thames. But this division, if made, must be geographical, and the drawing of the dividing line must cease to depend on whether a particular area is supplied by a publicly or privately owned undertaking. We are not certain that the importance of this is realised in some quarters. Now is the time for combination and not competition. Yet Mr. Benson announces the formation of a "little" company to be called The London Electricity (Joint Committee), 1920, Ltd., which will enable all the London companies to pool their resources and experience. The object of this Company, in Mr. Benson's phrase, is to save the Treasury from being appalled at the prospect of having to spend some £200,000,000 on the compulsory purchase of existing plant and the development of superstations. Mr. Benson thinks if the Treasury can be relieved of this burden that success will depend on two things: increased output of power and the restoration of the financial credit of the industry. With that we do agree, but where we join issue is that any scheme for the supply of London should be carried out by private enterprise alone. As we understand the policy of the Electricity Commissioners, there is to be no wholesale scrapping of existing plant, but a gradual unification of resources by extending the more modern stations and by discarding the older plant. In doing this there will be quite enough problems to solve without introducing those that can be avoided. And one of the latter is the attempt of any block of interests to start schemes of their own. We hope, therefore, that both the municipal and company authorities in London will realise the necessity of coming together not only for their own, but for the common good. In this respect the Kilkenny cat policy mentioned above has been rather too much to the fore in the past.

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A Change in Rotary Converter Design.

Opinion on the subject of whether the use of oscillators on rotary converters is justified by any practical advantages is rather divided in this country. As is not unusual in matters of this kind there are those who are perfectly sure there are distinct advantages and others who are as perfectly sure that there are nothing but disadvantages. In matters such as these practice can be the only test, and the ultimate proof in this, as in other matters, is whether the device in question is bought and used. Those who held the view that oscillators on rotary converters were not necessary and were only insisted upon by station engineers in this country because their use had originally been recommended by American designers will be interested in an announcement in a recent issue of "Power" to the effect that the Westinghouse Electric & Manufacturing Company during 1919 made a series of service tests to determine the value of oscillators on rotary converters and as a result this device is being omitted from the Company's standard synchronous convertors. They will also be interested to learn that its omission has allowed improved operation to be obtained. The same view seems to have been recently gaining ground in this country, as in the course of the discussion on Mr. Hunter Brown's Paper on "Carbon Brushes, considered in Relation to the Design and Operation of Electrical Machinery," recently read before the Institution of Electrical Engineers, several speakers stated that the addition of an oscillating gear to a commutating machine was a hindrance rather than a help. In spite of this it still makes its appearance in some current specifications, but as a result of this announcement we hope it will now be dropped.

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The Tramways Dilemma.

If we are to judge from a memorandum drawn up by a Sub-Committee of the Municipal Tramways Association, the municipal tramways of this country are in an alarming financial state. We cannot say that we are surprised. Many municipal tramway schemes were "born out of due time" and like many such children have not only been weakly but have had time and money spent on them which have been denied to more healthy progeny. But all the care has done them little good. They have always been ailing and now their state is critical. "Almost every tramways system," says the memorandum is being "carried on at a loss, which, in many cases, is more than 1d. per car-mile." Then, in addition, there is the usual demand for increased wages from the employees and the usual hostility of the public to an increase in the fares. A conference of tramways authorities is to be held in London next week to examine the patient, but the General Secretary thinks that if the tramways industry is to be continued either the fares must be substantially increased or tramways must depend upon compulsory local rates. In other words, if the townspeople won't pay directly they must pay indirectly. Not a very happy state of affairs! But of the two we think the former more preferable as it is essential in our opinion that the rider should pay at least the actual cost of the ride. The aim of the Association should be to make each undertaking self-supporting and to get rid of subsidies as soon as possible. Some tramways systems have, however, never been in that fortunate position, owing to well-known reasons not unconnected with local politics, and it looks now as if they never will be.

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Electricity Supply in Australia.

We have just received a copy of a report of the Electricity Commissioners of the State of Victoria, Australia, on the question of the ultimate requirements of that State in the realms of electricity supply and especially as regards providing Melbourne as quickly as possible with the extra energy that it most urgently requires. The means of doing this are three: the utilisation of either or both of two brown coalfields or of the water power of the Kiewa River. The first of these coalfields is situated at Morwell, about 80 miles distant from Melbourne. Here some 120,000,000 tons of brown coal are available which can be won by the open cut method of operation. This quantity is sufficient in the Commissioners' opinion to provide a 100,000-kw. power-station with the fuel it will require for about 150 years. So that whatever posterity may think of the scheme there is no doubt that it has advantages when viewed in the present. The Commissioners do not, however, intend to erect so large a station at present, but will in the first instance provide one with a capacity of 40,000 kw., or sufficient to take care of the requirements of the Melbourne metropolitan area in 1923. To do so will incidentally mean that the Melbourne City Council and

Melbourne Electric Supply Company must take all their power from the new stations, but seeing that they will save money by so doing the Commissioners have no doubt apparently that they will fall in with this arrangement and so ensure the success of the scheme. Australia seems to be different from this country in some ways!

A Quickly Adopted Scheme

THE other coalfield which was considered is at Altona, but, though much nearer to Melbourne and situated on the shores of Port Philip Bay where an unlimited supply of cooling water is available, it has the disadvantage that the coal seam is some 350 ft. below the surface and would therefore be more expensive to work than the Morwell field. It is, therefore, recommended that the development of this field should be postponed for the present. The hydro-electric scheme considered was that on the Kiewa River, some 133 miles from Melbourne. But on this site it would only be possible to generate some 35,000 kw. with no hope of further extension. It is, therefore, recommended that this scheme also be dropped and that the Morwell scheme of a 50,000-kw. station be proceeded with at once at an estimated total capital expenditure of £2,737,392, including distribution cables and sub-station equipment in Melbourne. This station should be, it is suggested, linked up with the existing station at Newport and both operated under the same authority. The report in question is dated November 26, 1919, and in a covering letter dated December 23, 1919, which accompanies it the Secretary to the Commissioners informs us that the report has been adopted by the Victorian Government, the necessary Bill has been passed and steps are now being taken to push on with the scheme forthwith. All in a month! It leaves us breathless.

Current Topics.

Subjects of interest dealt with in the current issue include the following:—

Mr. F. F. P. Bisacre completes his article on "The Calculation of Track Pressure Drop and Track Losses on Direct-current Railways" on page 214.

We conclude on page 217 our abstract of Major Kenelm Edgcumbe's Paper on the "Protection of Alternating-current Systems without the Use of Special Conductors," and give an account of the discussion which took place on this Paper at a recent meeting of the Institution of Electrical Engineers in London.

On page 220 we give an illustrated description of the works of the Chloride Electrical Storage Company at Clifton Junction, near Manchester. These works have been largely extended during the past few years, and secondary batteries of all sizes and outputs are now manufactured there.

We begin a detailed account of the exhibits at the British Industries Fair at Birmingham on page 222.

Our usual serial article on the progress that has been made in the design and manufacture of heating and cooking apparatus appears on p. 223.

We publish several interesting letters from our readers on p. 224.

Our leading article this week deals with differing opinions which have recently been put forward on the question of the best curriculum to be followed by the student training for the electrical engineering profession, and as to how far commercial subjects should be brought into this curriculum. The various views expressed are commented on. (p. 227.)

Extracts from the speeches of the chairmen of the railway companies, referring to the success of electric traction and to new proposals for its extension, are given on p. 228.

In our legal columns an important judgment on Trade Union law is given, and also the report of an action between Submarine Cable Companies as to a condition in a lease of one of the Atlantic submarine cables. (Page 229).

Reports of the meetings of the Underground Electric Railway Companies of London, which give particulars of projected improvements, traffic returns, &c., will be found on p. 234.

Arrangements for the Week.

FRIDAY, Feb. 27th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers on "The Balancing of Errors," by Mr. [illegible] Smith, B.A.; "Notes on the Testing of Bars of Magnet Steel," by Dr. N. W. McLachlan; "On the Forces Acting on Heated Metal Foil Surfaces in Rarefied Gases," by Mr. G. D. West, M.Sc.; and Exhibit of Crystal Models, by Miss N. Heath.

INSTITUTION OF ELECTRICAL ENGINEERS.—LIVERPOOL STUDENTS' SUB-CENTRE.

7.30 p.m. At the University, Liverpool. Paper on "Central Station Boiler Practice," by Mr. K. Habershon.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Defects Found on Inspection of Boilers," by Mr. R. H. Kenyon.

JUNIOR INSTITUTION OF ENGINEERS.—SHEFFIELD SECTION.

7.30 p.m. At the Cutlers' Hall, Sheffield. Paper on "Scientific Instruments," by Mr. J. A. Swift.

WIRELESS SOCIETY.

8 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Address on "Some Wireless Wonders," by Mr. A. A. Campbell Swinton, F.R.S.

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, London, W. Discourse on "Problems of Lubrication," by Mr. W. B. Hardy, F.R.S.

SATURDAY, Feb. 28th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, London, W. Lecture on "Positive Rays," by Prof. Sir J. J. Thomson, O.M., F.R.S. (Lecture II.)

STOKE-ON-TRENT ASSOCIATION OF ENGINEERS.

7 p.m. At the Town Hall, Hanley, Stoke-on-Trent. Lecture on "Cementation as Applied to Mining," by Mr. T. T. Mawson.

MONDAY, March 1st.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Recent Research in Cellulose Industry," by Mr. C. F. Cross, B.Sc. (Lecture III.)

INSTITUTION OF ELECTRICAL ENGINEERS—INFORMAL MEETING.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn Buildings, High Holborn, London, W.C. Paper on "The Future of Labour in the Engineering Industry," by Mr. R. E. Dickinson.

INSTITUTION OF ELECTRICAL ENGINEERS—WESTERN CENTRE.

7 p.m. At the Merchant Venturers' Technical College, Bristol. Lecture on "Electric Clocks," by Prof. D. Robertson.

TUESDAY, March 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS—NORTH-WESTERN STUDENTS' CENTRE.

7.30 p.m. At Houldsworth Hall, Deansgate, Manchester. Paper on "Insulating Oils," by Mr. H. Butterworth.

RONTGEN SOCIETY.

8 p.m. At the Royal Society of Medicine, I, Wimpole-street, London, W. Silvanus Thompson Memorial Lecture on "Analysis by X-Rays," by Prof. W. H. Bragg, F.R.S.

WEDNESDAY, March 3rd.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN

7.30 p.m. At the University, Liverpool. Lecture on "The Una-Flow Steam Engine," by Mr. D. H. Yates.

INDUSTRIAL LEAGUE AND COUNCIL.

7.30 p.m. At Central Hall, Westminster, London, S.W. Subject: "Economical Production and Prevention of Waste," by Mr. H. Atkinson.

THURSDAY, March 4th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. At the Connaught Rooms, London W.C. Annual Dinner.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

8 p.m. At Milton Hall, Manchester. Lecture on "The Screw Propeller," by Mr. P. Doig.

FRIDAY, March 5th

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Notes on Gauge Testing and Measuring Appliances," by Mr. F. H. Rolt, B.Sc.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

7.30 p.m. At the University, Sheffield. Paper on "Flat Plates," by Mr. C. C. Pounder.

7.30 p.m. At the Technical School, Barrow-in-Furness. Lecture on "Gearing Design," by Mr. M. Coronel.

INSTITUTION OF ELECTRICAL ENGINEERS' STUDENTS' MEETING.

7 p.m. At the City and Guilds (England) College, S. Kensington, London, S.W. Address by the president, Mr. R. T. Smith.

The Calculation of Track Pressure Drop and Track Losses on Direct Current Electric Railways.

By F. F. P. BISACRE, M.A., B.Sc., A.M.Inst.C.E.

(Concluded from p. 189.)

SUMMARY OF PRESSURE DROP CALCULATIONS.

A. Sub-stations at Both Ends of Section.—1. Graphically or by means of $L=(n-1)d+2q$ find n, the *maximum* number of trains between sub-stations.

2. If n is odd, calculate pressure drop by (5).

3. If n is even, calculate pressure drop for first symmetrical position by (6) or (10), and for second symmetrical position with $(n-1)$ trains by means of (5).

B. Spur Lines.—1. Assume a train starting at the far end, and calculate pressure drop by (5), adding a term $(\frac{1}{2}I_{\max} rL')$ to the result from (5).

Example.—Sub-stations at both ends

$d=1{\cdot}5$ miles.
$L=7$ miles.
$I_{\text{av}}=140$ amperes.
$I_{\max}=700$ amperes. $\therefore\ a=4$.
$r=0{\cdot}125\ \omega$ per mile.
$E=1{,}500$ volts = line voltage.
$L=(n-1)d+2q$ gives
$n=5$ and $q=0{\cdot}5$;

hence by (5) (since n is odd)

$$\delta E=\frac{140\times0{\cdot}125}{2}[1{\cdot}5\{4+4(4-1{\cdot}5)\}+5\times0{\cdot}5\times(1-1{\cdot}333)].$$

$=235$ volts.

$\therefore$ Per cent. regulation $=15{\cdot}8$ per cent.

This example is typical of railway conditions, and in this case the regulation would be good. 56 per cent. of the total drop depends on the term which is proportional to a.

Track Loss Calculations.—The calculations for spur lines are much simpler in form than those for double-ended lines, and will be dealt with first.

Spur Lines.

Let Fig. 5 represent the general case, O being the sub-station. Take the zero of time from the instant when train No. 1 is at O, and suppose the n trains move from left to right at speed v miles per hour. There will evidently be no current in the section of the line to the right of the nth train.

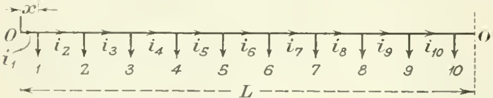

Fig. 5.

Let $L=(n-1)d+q$ for spur lines, where d = distance between trains, and q = overlap at end. At instant t hours later, the trains are displaced to the right a distance $x(=vt)$ miles.

The nth train is then a distance $(q-x)$ from the end O'. Let r = track resistance per mile of complete circuit (positive and negative).

The loss of energy in watt-hours during a time δt is

$$\delta\epsilon=r[i_1^2x+d(i_2^2+\ldots i_n^2)]dt, \quad \ldots \quad (11)$$

where i's are the currents in the sections between trains as indicated in the figure.

This equation holds for a time q/v, after which instant the nth train is no longer in the section OO'.

The loss of energy in watt-hours during the period from $t=0$ to $t=q/v$ is therefore

$$\epsilon_1=r\int_0^{\frac{q}{v}}[i_1^2x+d(i_2^2+\ldots i_n^2)]\delta t. \quad \ldots \quad (12)$$

Now, $\delta x=v\delta t$.

$\therefore$ (12) can be put

$$\epsilon_1=\frac{r}{v}\int_0^q[i_1^2x+d(i_2^2+\ldots i_n^2)]\delta x. \quad \ldots \quad (13)$$

During the second period from $t=q/v$ to $t=d/v$, we have

$$\epsilon_2=\frac{r}{v}\int_q^d[i_1^2x+d(i_2^2+\ldots i_{n-1}^2)]\delta x. \quad \ldots \quad (14)$$

The total loss in watt-hours is $(\epsilon_1+\epsilon_2)$, and this takes place in d/v hours, hence

$$\text{Losses (average) in watts}=\frac{v}{d}[\epsilon_1+\epsilon_2] \quad \ldots \quad (15)$$

Constant and Equal Currents to Each Train.—During the first period

$i_n=I$, where I = current per train,
$i_{n-1}=2I$,
. . . . . .
$i_1=nI$,

whence, by (13)

$$\epsilon_1=\frac{rI^2}{v}\left[\frac{n^2q^2}{2}+d\left\{\frac{n(n-1)(2n-1)}{6}\right\}q\right].$$

During the second period

$i_{n-1}=I$,
$i_{n-2}=2I$,
. . . . . .
$i_1=(n-1)I$,

whence, by (14)

$$\epsilon_2=\frac{r}{v}I^2\left[\frac{(n-1)^2(d^2-q^2)}{2}+d\left\{\frac{(n-1)(n-2)(2n-3)}{6}\right\}(d-q)\right].$$

and, by (15)

$$\text{Average loss in watts}=\frac{rI^2}{d}\left[\frac{n^2q^2+(n-1)^2(d^2-q^2)}{2}\right.$$
$$\left.+d\left\{\frac{(n)(n-1)(2n-1)q+(n-1)(n-2)(2n-3)(d-q)}{6}\right\}\right] \quad (16)$$

When $q=0$, this reduces to

$$\text{Average loss in watts}=rI^2d\left[\frac{(n-1)^2}{2}+\tfrac{1}{6}(n-1)(n-2)(2n-3)\right] \quad (17)$$

Variable Currents.—This case can be dealt with by making a similar assumption as to the effect of diversity as that made in the pressure drop calculations.

Assume that the heating effects of currents in sections between trains are the same as they would be if each train took an equal and constant current of the average value, but multiplied by a factor which varies hyperbolically with the section considered.

Thus, in the section feeding one train only, the heating current is clearly the R.M.S. current—*i.e.*, $I_{\text{av}}(1+\beta)$, where $\beta=\left(\frac{J-I_{\text{av}}}{I_{\text{av}}}\right)$ and J = R.M.S. current per train. In the section through which two trains are fed, the heating current is $2I_{\text{av}}(1+\beta/2)$, and so on.

Let $q=0$, then, by (15)

$$\text{Loss in watts}=\frac{r}{d}\int_0^d[i_1^2x+d(i_2^2+\ldots i_{n-1}^2)]\delta x.$$

The currents are

$i_{n-1}=f_1I_{\text{av.}}$,
$i_{n-2}=f_2I_{\text{av.}}\times2$,
$i_{n-3}=f_3I_{\text{av.}}\times3$,
. . . . .
$i_1=f_{n-1}I_{\text{av.}}\times(n-1)$,

where $f_m=\left(1+\frac{\beta}{m}\right)$, and J = R.M.S. current per train.

$$\therefore\ \text{Loss in watts}=\frac{r}{d}\int_0^d[f_{n-1}^2(n-1)^2I_{\text{av.}}^2x+d(f_{n-2}^2(n-2)^2$$
$$+\ldots f_1^2)I_{\text{av.}}^2]\delta x,$$

i.e., Loss in watts $= rI_{\text{av.}}^2 d\left[\sum_1^{n-1}(f_m^2 \cdot m^2) - \frac{f_{n-1}^2(n-1)^2}{2}\right]$ (18)

where r = track resistance per mile,
I_{av} = average current per train,
d = distance between trains in miles,
$f_m = \left(1+\frac{\beta}{m}\right)$, and J = R.M.S. current per train, and
$n = \frac{L+d}{d}$, where L = length of spur, q being zero.

This result applies whether n is odd or even.

Lines with Sub-stations at Each End.—The same method may be employed for this case, but the formulæ are more cumbrous.

Considerations of space prohibit anything more than a summary of the results of these calculations.

Let Fig. 6 represent this case. Currents are taken as positive when flowing from left to right. In Fig. 6, some of the i's will be negative.

Take the zero of time as the instant when train No. 1 is at O, and suppose the trains are moving to the right at speed v miles per hour. At instant t hours later, the trains have all moved a distance x to the right, where $x = vt$.

The nth train is $(2q-x)$ from O' at t. Let r = resistance per unit length of complete track circuit. Hence, losses in watt-hours during the period δt are

$$\delta\,(\text{Losses}) = r[i_1^2x + d\{i_2^2 + i_3^2 + \ .\ + i_n^2\} + i_{n+1}^2(2q-x)]\delta t. \quad (19)$$

This equation holds during the first period, viz., for $t=0$ to $t = 2q/v$., and, since $\delta x = v\delta t$,

$$\epsilon_1 = \frac{r}{v}\int_0^{2q}[i_1^2x + d\{i_2^2 + i_3^2 + \dots i_n^2\} + i_{n+1}^2(2q-x)]\delta x. \quad (20)$$

During the second period for $t = 2q/v$ to $t = d/v$, since there are $(n-1)$ trains in the section during this period, the result is

$$\epsilon_2 = \frac{r}{v}\int_{2q}^{d}[i_1^2x + d\{i_2^2 + \dots i_{n-1}^2\} + i_n^2(d+2q-x)]\delta x. \quad (21)$$

These formulæ apply whether n be odd or even.

The total losses during time d/v are given by

$$\epsilon = r/v[T_1 + T_2], \quad (22)$$

where T_1 = integral in (20),
T_2 = integral in (21) above.

T_2 can be put

$$T_2 = \int_{2q}^{d}[i_1^2x + d(i_2^2 + \dots i_n^2) + i_n^2(2q-x)]\delta x, \quad (23)$$

which, by comparison with (20) shows the difference in the two integrands.

The evaluation of these integrals is laborious even in the simplest case when the current taken by each train is constant and the same.

The formulæ for *uniform and equal currents* to all trains are collected below.

Let L = distance between sub-stations in miles.
d = distance between trains in miles.
n = maximum number of trains between sub-stations,
then $L = (n-1)d + 2q$, where q is a fraction $< \frac{1}{2}d$.

Assume that the rotary converters in each sub-station are all of similar design, size and number, so that the 'bus bar pressure in each sub-station is the same at any moment. The following equation holds under these conditions:—

$$i_1x + i_2d + \dots + i_nd + i_{n+1}(2q-x) = 0. \quad (24)$$

Also

$$\left.\begin{aligned} i_1 - i_2 &= I,\\ i_2 - i_3 &= I,\\ &\dots\\ i_n - i_{n+1} &= I, \end{aligned}\right\} \quad (25)$$

I being the uniform current taken by each train, equations (24) and (25) give $(n+1)$ equations to determine the $(n+1)$ quantities, i_1, i_2, i_3, &c.

From these equations, i_1 is given by

$$i_1 = \frac{I}{L}\left[\frac{n(n-1)}{2}d + n(2q-x)\right]. \quad (26)$$

$$= A_1 + B(2q-x), \quad (27)$$

where

$$\left.\begin{aligned} A_1 &= \frac{I}{L}\left[\frac{n(n-1)}{2}d\right]\\ \text{and}\quad B &= \frac{I}{L}\times n, \end{aligned}\right\} \quad (28)$$

i_2, &c., follow at once from (25).

The first integral, T_1, can now be evaluated. It is

$$\begin{aligned} T_1 = {} & [(n-1)A_1^2 - n(n-1)A_1I + \tfrac{1}{6}n(n-1)(2n-1)I^2]2qd.\\ & + \left[\left(A_1^2 + \frac{n^2I^2}{2} - nIA_1\right) + Bd\{(n-1)A_1 - \tfrac{1}{2}n(n-1)I\}\right](2q)^2.\\ & + \left[A_1B - \tfrac{2}{3}nIB + d\frac{(n-1)}{3}B^2\right](2q)^3.\\ & + \frac{B^2}{3}(2q)^4. \end{aligned} \quad (29)$$

The second integral is found to be

$$\begin{aligned} T_2 = {} & 2q\left[A_1^2p - A_1B_1p^2 + \frac{B_1^2p^3}{3}\right] - \frac{n-1}{2}[(n-1)I^2 - 2IA_1]p^2.\\ & - \tfrac{2}{3}(n-1)IB_1p^3.\\ & + [\{(n-1)A_1^2 - n(n-1)A_1I + \tfrac{1}{6}n(n-1)(2n-1)I^2\}]pd.\\ & - [(n-1)A_1 - \tfrac{1}{2}n(n-1)I]B_1p^2d.\\ & + \frac{n-1}{3}B_1^2p^3d. \end{aligned} \quad (30)$$

where the symbols have the same meaning as before and

$$B_1 = \frac{I}{L}\times(n-1)$$

and $p = (d-2q)$.

The average loss in watts is

$$\text{Loss} = \frac{r}{d}[T_1 + T_2], \quad (31)$$

where T_1 and T_2 are given by (29) and (30) in terms of determinate constants, A_1, B, B_1, n, I, d, and q.

The general formulæ can be greatly simplified in the important case when $q = o$.

T_1 is then zero and $p = d - 2q = d$, and the losses reduce to

$$\text{Loss in watts} = \frac{rI^2L}{12}[n^2 - 2n + 2]. \quad (32)$$

If a uniformly distributed load be assumed of amount I' out of each sub-station, where

$$I' = \left(\frac{n-1}{2}\right)I. \quad (33)$$

The loss is

$$\tfrac{1}{3}rL\left(\frac{n-1}{2}\right)^2I^2,$$

i.e., $$\text{loss} = \frac{rLI^2}{12}(n-1)^2 \quad (34)$$

$$= \frac{rI^2L}{12}(n^2 - 2n + 1).$$

The *true* loss therefore exceeds the loss calculated on the uniformly distributed load basis by $rLI^2/12$, or the true loss is higher than the "distributed" loss by

$$\left\{\frac{100}{(n-1)^2}\right\}\text{per cent.}, \quad (35)$$

when $n > 2$, *i.e.*, when there is always *at least* one train between sub-stations.

Variable Currents.—Fig. 6 also represents this case. The current at any point between the sub-station is assumed to be equal to what it would be, if each train took its average current I_{av}, but multiplied by a factor f, which is greater than unity, and follows the hyperbolic law.

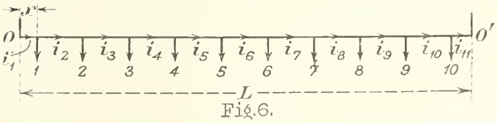

Fig.6.

Just as in the previous calculation, this factor is written

$$f_1 = \left(1 + \frac{\beta^2}{p}\right), \text{ where } \beta = \frac{J - I_{av.}}{I_{av.}},$$

where $J =$ R.M.S. current per train.

$I_{av.} =$ average current per train.

β is usually < 1. When $\beta = 0$, we have equal and constant currents to each train.

It is proposed to confine this calculation to the case when $q = o$.

The loss in watts is given by

$$\text{Loss} = \frac{r}{d}\int_0^d [i_1^2 x + d(i_2^2 + \ldots i_{n-1}^2) + i_n^2(d-x)]\delta x \text{ (see 21)} \quad (36)$$

$$= \frac{r}{d}\left[d\sum_2^n \int_0^d i_m^2 \delta x + \int_0^d (i_1^2 - i_n^2)x\delta x\right]. \quad . \quad . \quad . \quad . \quad . \quad (37)$$

$$\left.\begin{array}{ll} \text{where} & i_1 = A_1 - B_1 x \\ & i_2 = A_2 - B_1 x \\ \text{and} & i_n = A_n - B_1 x \\ \text{having} & A_1 = \dfrac{I_{av.} \times n}{2} \\ \text{and} & A_n = A_1 - (n-1)I_{av.}, \\ \text{and} & B_1 = \dfrac{I_{av}}{d}. \end{array}\right\} \quad . \quad . \quad . \quad (38)$$

With these equations we get

$$\int_0^d (i_1^2 - i_n^2)x\delta x = -\tfrac{1}{6} \cdot \frac{I_{av.}^2 L^2}{(n-1)}, \quad . \quad . \quad . \quad . \quad (39)$$

and the equation (36) becomes

$$\text{Loss} = r\left[\sum_2^n \int_0^d i_m^2 \delta x - \frac{I_{av.}^2 L}{6}\right]. \quad . \quad . \quad . \quad . \quad (40)$$

The correcting factors must now be introduced, giving

$$\text{Loss} = r\left[\sum_2^n \int^d f_p^2 i_m^2 \delta x - f_n^2 \frac{I_{av.}^2 L}{6}\right] \quad . \quad . \quad (41)$$

where i_m = value of current in mth section, assuming each train takes a constant current I_{av}.

To determine i_m there are the equations (38) above.

The summation integral is best found numerically, noting that

$$\int_0^d i_m^2 \delta x = \left[A_m^2 d - A_m B_1 d^2 + \frac{B_1}{3} d^3\right]. \quad . \quad . \quad . \quad . \quad (42)$$

The factors f_p and f_n to take with each integral can be readily seen by inspection of the terms in the table. The integral (or integrals—there may be two) giving the lowest losses, correspond to the central sections where diversity is a minimum f_1 is therefore taken with these integrals: f_2 is taken with the next lowest, and so on.

Example:

$d = 1$ mile.
$L = 8$ miles.
$r = 0{\cdot}125\ \omega$ per mile.
$I_{av} = 190$ amperes.
$\beta = 0{\cdot}5$.
$n = 9$ and $q = 0$.

Then, $A_1 = \dfrac{190 \times 9}{2} = 855$—by (38).

$B_1 = 190$—by (38).

The figures may now be tabulated.

—	A_m.	B_1.	$A_m^2 d$.	$-A_m B_1 d^2$.	$\frac{B^2}{3} d^3$.	$t_1 = \int i^2 dt$.	f^2.	$f^2 \times t_1$.
$\int_0^d i_2^2 \delta x$	665	190	442,000	−126,000	12,000	328,000	1·265	415,000
$\int_0^d i_3^2 \delta x$	475	190	226,000	−90,000	12,000	148,000	1·360	201,000
$\int_0^d i_4^2 \delta x$	285	190	81,300	−54,000	12,000	39,000	1·560	61,200
$\int_0^d i_5^2 \delta x$	95	190	9,030	18,000	12,000	3,000	2·250	6,820
$\int_0^d i_6^2 \delta x$	−95	190	9,030	+18,000	12,000	39,000	1·560	61,200
$\int_0^d i_7^2 \delta x$	285	190	81,300	+54,000	12,000	148,000	1·360	201,000
$\int_0^d i_8^2 \delta x$	−475	190	226,000	+90,000	12,000	328,000	1·265	415,000
$\int_0^d i_9^2 \delta x$	−665	190	442,000	+126,000	12,000	580,000	1·210	700,000
								2,061,220
				Deduct	$I^2L/6$	48,200	1·210	58,200
								2,003,000

$$\text{Loss} = \frac{0{\cdot}125 \times 2{,}003{,}000}{1{,}000} = 250 \text{ kw.}$$

The last item, combined with the deduction $I^2L/6$, gives the value of the two integrals

$$\frac{r}{d}\int_0^d i_1^2 x\delta x \text{ and}$$

$$\frac{r}{d}\int_0^d i_n^2(d-x)\delta x.$$

The sum is, neglecting the correction factor, 580,000 − 48,200 = 531,800, and by symmetry each integral must obviously contribute an equal amount to the total loss; so each contributes 265,600. This may be directly checked by noting that

$$\frac{r}{d}\int_0^d i_1^2 x\delta x = r\left[\frac{A_1^2 d}{2} - \tfrac{2}{3}A_1 B_1 d^2 + \frac{B_1^2 d^3}{4}\right]$$

and that

$$\frac{r}{d}\int_0^d i_n^2(d-x)\delta x = r\int_0^d i_n^2 \delta x - \frac{r}{d}\int_0^d i_n^2 x\delta x,$$

where

$$\int_0^d i_n^2 x\delta x = \left[A_n^2 \frac{d^2}{2} - \tfrac{2}{3} \cdot A_n B_1 d^3 + B_1^2 \frac{d^4}{4}\right].$$

When q is Not Zero.—The above investigation applies only when $q = 0$. When q does not equal zero, the losses can best be calculated by figuring for

$L_1 = (N-1)d \qquad n = N.$
and $L_2 = N \cdot d. \qquad n = N+1,$

and interpolating the loss for the actual length L by proportion. This is sufficiently accurate for most purposes.

Conclusion.—In these calculations the trains are assumed to be spaced at regular intervals d miles apart. When this is not so, by making use of the formulæ for trains at regular intervals, limits can usually be set, within which the required quantity must lie.

The results are greatly simplified by the assumption that the distance between sub-stations L (or the length of a spur L) is an exact multiple of d, and there is no objection to this assumption if curves are used to exhibit the results. Values of L which *are* exact multiples of d serve as well as any other values for curve plotting.

In an actual railway layout a set of curves for (1) *pressure drop per ohm of track resistance per mile,* and (2) *losses per ohm of track resistance per mile,* in terms of L, for different values of d, gives all the electrical information required in problems of distribution. These curves should be plotted on the basis of a sub-station at each end of the section and of a sub-station at one end only. The current time curve for the heaviest train settles the average current per train $I_{av.}$, and, with a given d, no other information is required to plot these curves. They follow at once from the results already given.

A single set of curves can be used for trains of different weights, as the pressure drop per ohm of track resistance per mile is proportional to the weight of train, and the track losses per ohm of track resistance per mile are proportional to the square of the weight of train, if a standard motor equipment is used throughout.

The Protection of Alternating-Current Systems Without the Use of Special Conductors.*†

By Major KENELM EDGCUMBE, R.E.(T.).

(Concluded from page 194.)

Typical Protection Diagrams.

In Figs. 5 and 6 are shown a number of typical feeders, &c., with the method of protection recommended for each. The points at which circuit breakers and relays are required are marked by a cross, and against each is given the number of the figure in which will be found a connection diagram of the protective device recommended. Practically every system can be divided up into elements such as those shown and the whole dealt with in the way proposed.

Methods of Earthing the System.

It is usually possible to connect the neutral points of all the generators to a common bar which is earthed through a resistance. A possible disadvantage of this arrangement is that if the triple harmonic of the wave form is very pronounced a current will circulate between the machines. The heating effect of this current is not serious, in fact a triple harmonic current equal to as much as half the full-load current of the generator will increase its copper loss by less than 3 per cent. At the same time, such circulating currents may be objectionable in their effects upon measuring instruments, &c., and they can be eliminated either by earthing only one generator at a time or by connecting a part of the resistance between each neutral point and the earthing bar.

In lieu of a resistance in the earth circuit the use of a reactance has been proposed, but such an arrangement suffers from serious disadvantages. In the first place the potential difference at its terminals is nearly 90° out of phase with the current flowing through it, so that the neutral point is raised to a very much higher potential above earth than would otherwise be the case. A still more serious objection to be urged against a reactance lies in its effect upon surges and oscillations. A non-inductive resistance connected between the neutral point and earth has proved a most potent factor in damping out over-pressures, whether due to internal or to atmospheric causes. A reactance, on the other hand, not only does not damp them out but may form, with the capacity of the system, an oscillatory circuit of its own. Such a reactance carrying a fault current represents a large amount of magnetic energy stored up, which is suddenly returned to the system as electrical energy directly the circuit is opened and constitutes, in itself, a fruitful source of over-pressures. The use of a reactance, therefore, is only permissible when combined with sufficient ohmic resistance to limit the earth current to a small value, that is to say, on systems working with a more or less "floating" neutral. In a modern station running with an earthed neutral the use of a reactance cannot be regarded as a practical proposition.

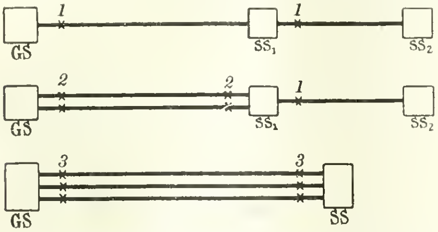

Fig. 5.—Protection of Independent Feeders. (The numbers are those of the corresponding figures in the text.)

Magnitude of the Current to be Passed.

It is well to provide leakage or differential tripping, at any rate on the larger breakers, so as to ensure the rapid isolation of the fault, and if this is done throughout it will, in most cases, allow a considerable reduction in the capacity of the earthing resistance. Whilst it is impossible to lay down any hard and fast rules as regards the current-settings of the relays or the best value for the earthing resistance, since each case must be considered upon its merits, the table below may serve as a guide. In calculating the setting on the lines of column 2, allowance

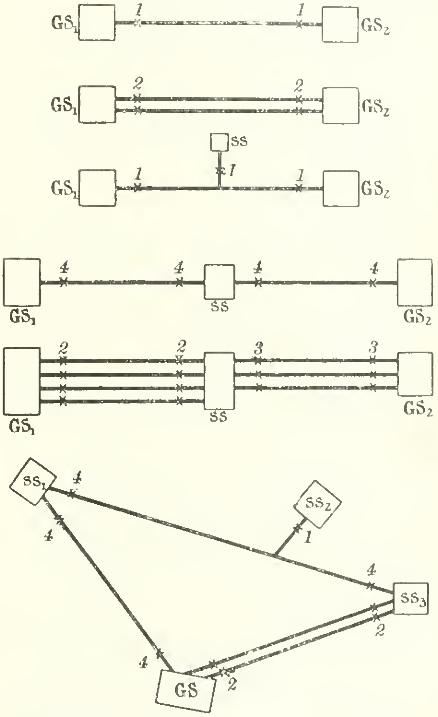

Fig. 6.—Protection of Interconnectors and Rings. (The numbers are those of the corresponding figures in the text.)

Form of Protection.	Current-setting of Relays.	Minimum Current in Earthing Resistance.
Overload as in Fig. 1	150 % of feeder capacity	150 % of capacity of largest feeder
Overload as in Fig 4	150 % " "	150 % " " "
Differential reverse relay as in Figs. 2 or 3	70 % " "	80 % " " "
Differential reverse relay, biased	20 % " "	25 % " " "
Leakage relay as in Fig. 1	80 % of earthing resistance current	20 % " " "
Leakage relay as in Fig. 4	80 % " " " "	40 % " " "
Merz-Price or Merz-Beard generator protection	50 % of generator capacity	70 % of capacity of largest generator
Reverse relay generator protection	25 % " "	35 % " " "

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* Abstract of a Paper read before the Institution of Electrical Engineers.

† The expression "protection," used in this sense, is well established, but in the author's opinion is somewhat of a misnomer. To speak of the "isolation of faults" would be better, since no circuit breaker "protects" a system against the occurrence of a fault. Its functions are limited to the isolation of the faulty section.

must be made for the distribution of the fault current between parallel feeders, should such exist. In applying the third column it will often be found that the generator protection entails a larger current than the feeders. With differential overload generator protection the current-setting cannot be reduced to a very small value for fear that a want of balance should cause it to operate with a heavy forward current. In this connection the author would suggest that the relays might advantageously be given a percentage bias control since the comparatively heavy current required for the operation of the generator relays is a serious disadvantage, neutralising to a large extent the benefits of leakage protection for the feeders. With reverse relay protection, this objection does not apply to the same extent since the operation depends upon the direction and not upon the magnitude of the current.

When "straight-through" current transformers are used, as should be the case wherever possible, the value of the current passed by the earthing resistance should not be less than 100 amperes. With an earthing resistance having a negative temperature coefficient the figures given in the last column may be taken as being the initial current. If the resistance has a positive temperature co-efficient they must be approximately doubled.

Methods of Tripping.

The necessary current for operating the trip coils of the circuit breakers may be derived from any of the following sources: (1) Alternating current supplied by a potential transformer, (2) Alternating current derived from a current transformer in the circuit affected, (3) Direct current from a battery or dynamo, (4) Direct current from an a.c.—d.c. machine upon a principle suggested by Mr. F. Ayton.

The first method is to be deprecated unless an entirely independent source of alternating current is available, and the second should only be adopted when no other is possible. When method 3 is available, it is by far the best, an accumulator battery being the ideal arrangement. For sub-stations and other situations where there is no available source of direct current, Mr. F. Ayton, some years ago, suggested to the author a system which might perhaps be called "momentum tripping." The method consists in driving a small direct-current generator from an alternating-current motor, the generator serving as a source of energy for actuating the circuit breakers. In order that there might be no possible lack of direct current, even in the event of the failure of the alternating-current supply the set was to be provided with a very heavy flywheel. Calculation shows that the weight of the flywheel required to give an ample reserve of power is by no means excessive. At the same time, ingenious as this proposal is, a storage battery undoubtedly forms the best flywheel.

The Checking of Relay Settings.

If accurate time and current settings are to be obtained, it is essential that the current transformer should have the required ratio curve over the working range and it is advisable for relays and current transformers to be tested in combination. In the case of differential and leakage tripping the actual ratio is of less importance than exact similarity of ratio curves. At the same time, it is well to test current transformers and relays as a single unit wherever this can be done.

Protection of current transformers against over-pressures is a matter of considerable importance since, whilst reasonable accuracy is required, freedom from breakdown is absolutely essential. In order to avoid a breakdown between turns, the use of straight-through current transformers is to be recommended wherever possible, but on the score of accuracy this cannot well be done if the setting of the relay operated by it is less than 100 amps. Where multi-turn current transformers have to be employed on lines liable to surges it is advisable to bridge the primary winding by a non-inductive resistance which forms a by-pass for the surge and thereby relieves the strain between the turns of the winding.

Conclusions.

The points which the author has endeavoured to make may be summed up as follows:—

(1) In any scheme of protection, continuity of supply should be the first consideration, simplicity the second, and adaptability the third.

(2) The neutral points of generators and step-up or step-down transformers should be earthed through a resistance having a negative temperature co-efficient.

(3) When the neutral point is not available the system can be earthed through a zig-rag transformer and an earthing resistance.

(4) In a large number of cases special conductors are out of the question, and any and every part of a distribution system can be protected by overload, reverse or leakage relays in accordance with one or other of three alternative methods as follows:—(*a*) For independent single feeders, combined overload and leakage protection with graded inverse time-lags (Fig. 1); (*b*) For independent parallel feeders, differential reverse relays with short inverse time-lags (Figs. 2 or 3); (*c*) A single interconnector between two generating stations can be treated as an independent feeder and protected at each end as in (*a*) above; (*d*) For a ring main consisting of single feeders, combined overload and leakage reverse relays with graded inverse time-lags (Fig. 4); (*e*) For interconnectors or ring mains composed of parallel feeders, differential reverse relays with short inverse time-lags (Figs. 2 or 3); (*f*) Any of the above arrangements can be supplemented by minimum voltage protection at the sub-stations where this seems advisable; (*g*) For the protection of generators running in parallel voltage, compensated reverse relays with short time-lags are effective against all faults and may be relied upon not to act prematurely.

(5) All overload relays must have similar time current curves, with a definite minimum independent of the overload.

(6) All reverse relays must be compensated for a fall of voltage down to 2 or 3 per cent. and may in some cases be required to operate with a heavy current in either direction at zero voltage.

(7) Current transformers should be of the straight-through type whenever possible and should otherwise be protected by a non-inductive shunt of ample current-carrying capacity and especially adjusted to the transformer characteristics.

DISCUSSION.

Mr. E. B. Wedmore remarked that in the arrangement of reverse current relays shown by the author, the two current transformers did not accurately balance. The force exerted by the restraining coils on the relays was small, but it would wipe out the effect of any unbalanced current, and it was proportional to the current in the feeders. It was, therefore, a sensitive device. The author described a novel system of employing earthed current relays for the protection of interconnectors and ring mains, but he (the speaker) was not satisfied that it would do all that was required of it. Currents might flow in either direction through the system, and if the relay was set to operate when they flowed in one direction it would not operate when they flowed in the other. But this was just what it was required to do when there were faults in the apparatus at the substation or on the feeders connected to the substation. Time-limit devices might be added to the relays and some discriminating action obtained, but he did not think that solution would oust the Merz-Price split conductor idea. The author described a novel reverse relay which had a discriminating action, but it involved earthing the middle point of the transformer, against which there was a prejudice. It was, however, the only device that gave a solution of the problem of a discriminating leakage relay. Reverse relay designers in the past had generally provided a relay which they said would open the circuit in any case under severe conditions, but that was as far as they had got. Many relays which had appeared satisfactory on paper failed. The device the author described of taking the potential connection for the relay off the two phases opposite to that from which the current was taken was a good one. A condenser was used to get the right phase relation in the relay which was given the maximum sensitiveness, say, 45°, and over the whole range of the leaking currents the relay was then nearly equally sensitive. The relay was safe for use with generators where the power factor might vary from a heavy lag to a moderately heavy load. In one case where this device was used with 20,000-volt mains there were 19 severe faults within three months, and the relay discriminated correctly in all of them. It should be noted that if there were a disturbance on one line adjacent lines were likely to be disturbed. Parallel feeders must be kept a quarter of a mile apart and be brought in by opposite routes.

Mr. J. R. Cowie said on big systems a selection of almost all known methods of protection could and must be used. The problem was governed not only by the high tension line characteristic, but also by the machine characteristics where there was mixed plant. The system of leakage protection of feeders described in the Paper was employed on every converting machine on the Glasgow system. Synchronous machinery had also a no-voltage coil. For feeder protection he used the Merz-Price gear and split conductor gear. The last line of defence in all cases was the overload relay at the power station or at important section points. It had an approximate time setting of one second. On selective protection devices he had apparatus which cleared a fault on light substation gear in the fourth or fifth period, and on the heavier gear in the third or fourth period, with a frequency of 25. The author advanced the American argument that all switches must be delayed so as to avoid a peak wave. That was good if it could be done. In the arrangement described by the author the gear was protected by inverse time limit overload protection, and that meant that some day the switchgear would get the top of the wave and would then have to clear it or there would be a disaster. There were, however, cases where nothing but overload protection was possible. He had a sneaking regard for the solenoid relay, chiefly because of its simplicity. He thought the Merz-Price failed because it came out on a straight-through fault. If the pilot cable went wrong, however, the protective gear was out of commission. Split conductor protection was very sensitive and required special cable and switches, but it had the advantage of increased loading. He had yet to find this system operate on a straight-through fault except where a two-core and a three-core cable had been put together and the balance was not perfect.

Mr. A. M. TAYLOR said when he heard of the compensated reverse relay described by the author his objection to it was that it acted on an overload current, and it still appeared to have that property. He did not like putting so many functions on the relay. Under what conditions of power factor were the operating currents obtained? The relay itself was interesting because it had got down to lower voltages of operation than had hitherto been the case. He had had the temerity to get hold of Steinmetz's "Transient Phenonena," and try to apply his equations and curves to three principal cases. The equations showed that under bad conditions of feeder arrangements it was possible, even when the circuit was broken where the current passed through zero, to get voltage oscillations up to double or treble the normal voltage, while if it was broken when the current was at its maximum, anything up to 10 or even 20 times the normal might be obtained. It was trading too much on good luck to assume that such a condition would never occur, and therefore it appeared that two points should urgently be striven for: as many trunk feeders as possible in parallel each absolutely independent of the other core-balance, and the most delicate protection obtainable in order to cut out every feeder before the leak to earth had time to develop into even a mild short circuit between phases.

Mr. G. W. PARTRIDGE agreed with the author when he said more interruptions of supply were caused by opening circuits prematurely than by leaving a fault on the system too long. When there was a short circuit between phases the later the switch acted the better, provided it acted quickly when it did act. In the system he controlled there was an occasion about three years ago when they got a capacity across the terminals of an oil switch, and when the circuit of 400 or 500 kw. was opened they were trying to snap the arc out right on the top of the wave. It blew the whole switch up. It was found the pressure went up to 25,000 volts on a 2,500-volt circuit. The simpler and fewer the relays used the better. He thought single conductors would be used underground when they worked at pressures of 30,000 to 60,000 volts, when the protection shown by the author would be most useful.

Mr. H. W. CLOTHIER said the author had realised the usefulness of leakage protection, the great point of which was that it operated instantaneously. The author wanted to couple on to it a time limit, thus removing its very virtue. Faults hanging on to a system were liable to create difficulty with plant running out of step and also dangers of fire. And while one was waiting for the relay to operate a fault to earth might develop into a fault between phases. The air dashpot which the author suggested using was more unreliable than the time limit fuse. The author said definite time limit devices were innocuous, and then he advocated inverse time limit devices. From the author's curve it seemed to him that the inverse time element only came into the first 50 per cent. of its time of operation. After that the inverse time limit relay evolved itself into a bad definite time limit device with very low setting.

Mr. H. BRAZIL thought maintenance of continuity of supply the chief thing that should be aimed at. He found the induction-type relay described by the author a very reliable piece of apparatus. He was strongly in favour of the inverse time lag. A lot of discussion arose as to the time current faults could be left on the system. If there were earthed resistances to limit the current and if it were remembered that 80 per cent. of the faults were to earth, it would be better to give them a chance to clear themselves rather than interrupt the supply. The author was wise in relying more on the setting by time lag than on a current setting. For the direct current circuit breakers had also to be considered. The best solution of the difficulty was to put reverse current relays on the direct current side of the motor generators, and a very slight time lag on the other side.

Dr. R. D. GIFFORD remarked that the author said if there were two parallel feeders and one was cut out the other would be left without protection, and he advocated putting in an overload relay. If one feeder developed a fault and was cut out the other would have to carry twice the load, and the overload protection would very likely operate. With two feeders in parallel of different cross sections the author said he would put in transformers having proper ratios. He (the speaker) presumed that was only a first approximation, as the current taken by two such feeders would not really be in proportion to the section of the feeders. Capacity and self induction would play a large part in the way in which the current would be split up between them, and there would be also heating and cooling characteristics to consider. Had the questions of capacity and self induction been provided for by using transformers having tappings on the secondary so that the ratio could be modified?

Mr. H. PEARCE said the reverse relay appeared to be satisfactory as long as the operating voltage was not less than 2 per cent. of the normal, but he thought this by no means low enough. If a feeder had a 4 per cent. impedance drop and a fault developed in which the current rose to 20 times normal that meant that the drop over the whole length of feeder was about 80 per cent. of the normal voltage. That was the most serious difficulty in the use of reverse relays, and the reason they had not been successfully used in this country. In America they used relays operating down to $\frac{1}{10}$ per cent. of normal voltage, which meant that the relay was liable to operate on a surge. They had a second relay operated by current only and they connected the contacts of the two relays in series so that the reverse relay would not operate unless there were at the same time an excess of current. The author gave the setting for Merz-Price apparatus as 50 per cent. of the generator capacity. The setting was from 20 to 50 amps. irrespective of the size of the machine. The reason for not using 50 per cent., as was formerly done, was that if a very delicate relay were used it would operate when the transformers carried overload currents.

The AUTHOR, replying to the discussion, said he had suggested graded time limits should be used so that if there were a fault on the feeders radiating from the generating station it would come out before reaching the substations. With regard to earthing the middle position of a potential transformer, that was a relic of the idea that it was essential that no other point but the neutral should be earthed. That did not apply to such systems as they were working on now, partly owing to capacity and partly to inevitable leaks. No one would object to putting a potential transformer between three mains earthed. Mr. Cowie suggested that leakage tripping arrangements should be fitted to consumers' premises. That would be an excellent thing, as much more trouble was caused on the consumer's premises than on the mains outside. Mr. Cowie said he started by using overload relays, and went on to say he preferred solenoid relays. If he had been trying to get discriminating tripping with solenoid relays he (the author) understood why he was not very successful. Mr. Taylor raised the question of reverse relays acting with a heavy forward current. He (the author) thought it desirable to have a reverse relay which would come out on a current of 20 times the setting. If the voltage fell to zero it was nearly all up with the continuity of supply, and the more points at which the circuits were opened the better. He had seen pressure regulators which he believed were satisfactory. Mr. Clothier said leakage protection must be instantaneous, and that that was its great virtue. The speaker thought its great virtue was that the current was absolutely under control. He did not think the air dashpot and time relay compared with the solenoid. Mr. Clothier objected to his saying it was a feature of the induction relay that the curve gradually fell off. That was when it was an inverse time limit. Having these relays set with their short time limits so that they would come out with a small overload seemed to be playing with fire. Dr. Gifford asked how overload protection could protect the two feeders when one of them had tripped because the other would carry double the current. It would carry double the current if the overload relay were set for double the current. Mr. Pearce described the American scheme of putting two relays in series. He (the author) had been rather against that. If one would do what was wanted it was simpler.

City of Savannah Pumping Plant.

The City of Savannah, Georgia, is now effecting a large saving every day on account of the installation of an electric motor-driven pump on an artesian well, furnishing 4,000,000 gallons of water daily to the city. The plant from which the city formerly got its water supply cost $65·00 a day to pump a million gallons of water, while the new equipment pumps at the rate of $10·00 a million gallons. If the city decides to install electric pumps throughout, and the indications are that it will do so shortly, a saving of $57,500·00 a year will be effected in fuel and labour.

The artesian well is 519 ft. deep, and was dug by the use of dynamite. A 24-in. casing was sunk to a depth of 110 ft., and from there to the bottom a 16 in. casing is used. The fact that this casing runs the full length of the well assures the consumer a supply of pure water. The pump, which is of the Layne & Bowler centrifugal type, is installed 100 ft. below the surface. It is driven by a 200-H.P., 2-phase, 60-cycle, 2,200-volt, 1,175-revs. per min. vertical induction motor, which was built by the Westinghouse Electric & Manufacturing Company. Current for the operation of the motor is supplied to the city by the Savannah Electric Company.

The Works of the Chloride Electrical Storage Co.

Interesting Developments in Secondary Battery Manufacture.

A visit which we recently paid to the works of the Chloride Electrical Storage Company at Clifton Junction enabled us to gather some idea of the development that has taken place in storage battery manufacture and application during the past few years. It is not so long ago that the storage battery seemed to have reached the limit of its usefulness, and there were people who prophesied that it would gradually fall into desuetude. If any such prophets had been with us on the occasion of our visit they would have been confounded, for it is evident that the storage battery industry is going very strong. There may be said to be two reasons for this. One, the invention and development of the ironclad battery, and the other the demands for an electrical supply unit for such purposes as driving vehicles of all kinds, not forgetting submarines, train lighting, miners' lamps, torches and many other similar applications, such as the very wide field opened up by car starters, car lighting and ignition. Which of these was the cause and which the effect we leave others to determine.

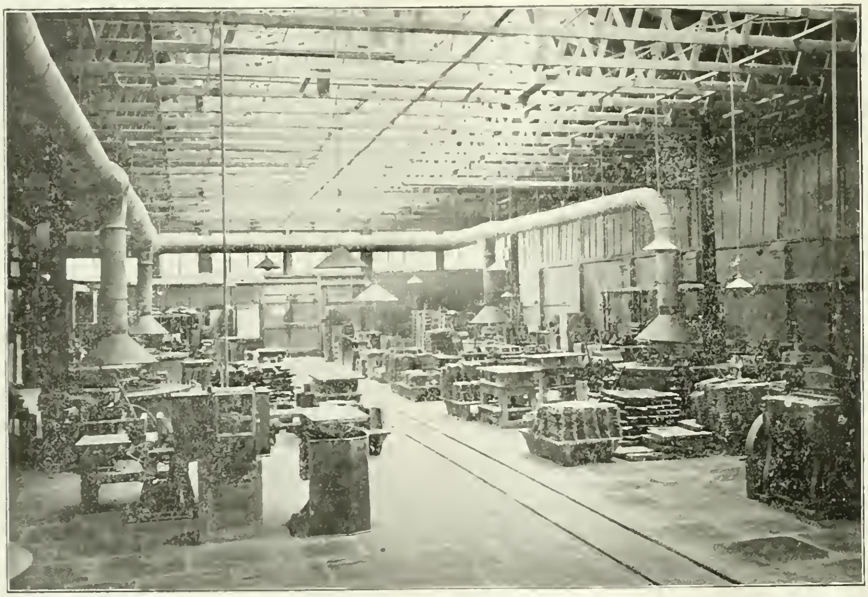


Fig. 1.—Plate Casting Shop.

The works at Clifton Junction are used for the manufacture of secondary batteries of both the "Chloride" and "Exide" type in all sizes and for all purposes. The former of these is, of course, a well-established piece of apparatus, which is, we understand, being turned out in ever-increasing quantities, not only for central station work, but for such applications as train lighting where the vibration is not excessive. Another reason why this battery is especially suitable for this purpose is that its efficiency does not suffer from overcharging, and it is obvious that the conditions under which railways are operated make it likely that the battery will be overcharged at times. The plates and rosettes for these cells are made in the factory along with the Exide equipment, and in general the same processes of manufacture are followed in the two cases. In addition to these two types of cell, a third, which is fitted with so-called "Plantide" plates, is also made. These correspond to the "Planté" plates made by other makers.

The batteries made at the Chloride Works are supplied in lead cases, teak cases lined with lead, thick glass boxes and celluloid cases, the latter being, of course, almost exclusively used for the smaller work, such as miners' lamps and torches, and also for starting and ignition batteries on cars. Glass cases are particularly recommended for train lighting, as it is easy to see the height of the electrolyte without the attendant having to twist his body into acrobatic positions, while it is found they are quite strong enough to withstand the usage they receive. On submarine batteries lead cases are employed.

The application of electric batteries to such purposes as torches and miners' lamps imposes the condition that the lamp must burn in any position, even upside down. In the "Exide" cell this is obtained by using a separator or veneer of porous wood of the poplar family between the plates, which absorbs a considerable portion of the electrolyte, and is reduced to cellulose. The effect of this is that when the cell used in the miners' lamp is inverted all the free acid passes away from the plates into the space below. Nevertheless, there is sufficient acid held by the separators to enable the cell to give discharge at half the ordinary rates. It may be mentioned that the use of such separators gives an increase of 10 per cent. in output over that obtained with the glass separators, while their life is equal to or slightly greater than that of the electrodes. It is also unnecessary with such cells that some arrangement should be made to prevent the escape of acid. In the "Exide" cells this is effected by an ingenious trap, consisting of two chambers, one inside the other, and with their outlets at right angles. This arrangement, while permitting the free escape of gas, renders, it is claimed, the escape of acid almost impossible. Such a trap is compulsory on miners' lamps and is, of course, desirable on all portable batteries.

Owing to the presence of acid, the question of the connections between the cells of the batteries is an important one. Burnt on connections have, of course, much to recommend them, but where screwed connections are used these are made of brass and are coated with vaseline. The ordinary burnt-on connections are of copper coated with lead.

As regards the processes of manufacture, the plates both for the "Exide" and "Chloride" cells are made from grids of a stiff lead alloy. These grids are cast in two halves in special moulds, supplied with the molten metal from gas heated furnaces. A network of soft lead is placed between these two halves, in the case of "Exide" cells, and they are then pressed together to form the plate on which the active material is pasted. The material used for pasting is oxide of lead mixed with a special composition which sets in drying like cement.

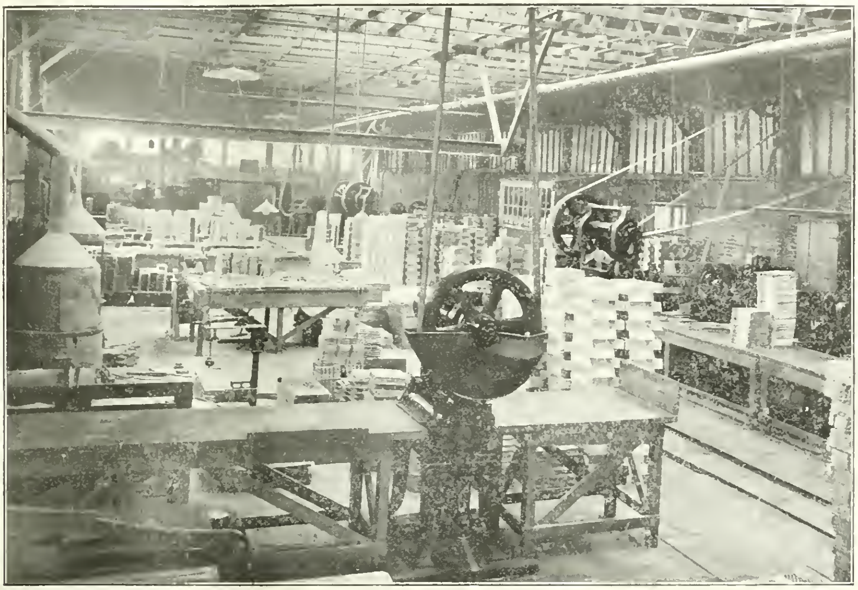


Fig. 2.—View in the Wood Working Shop

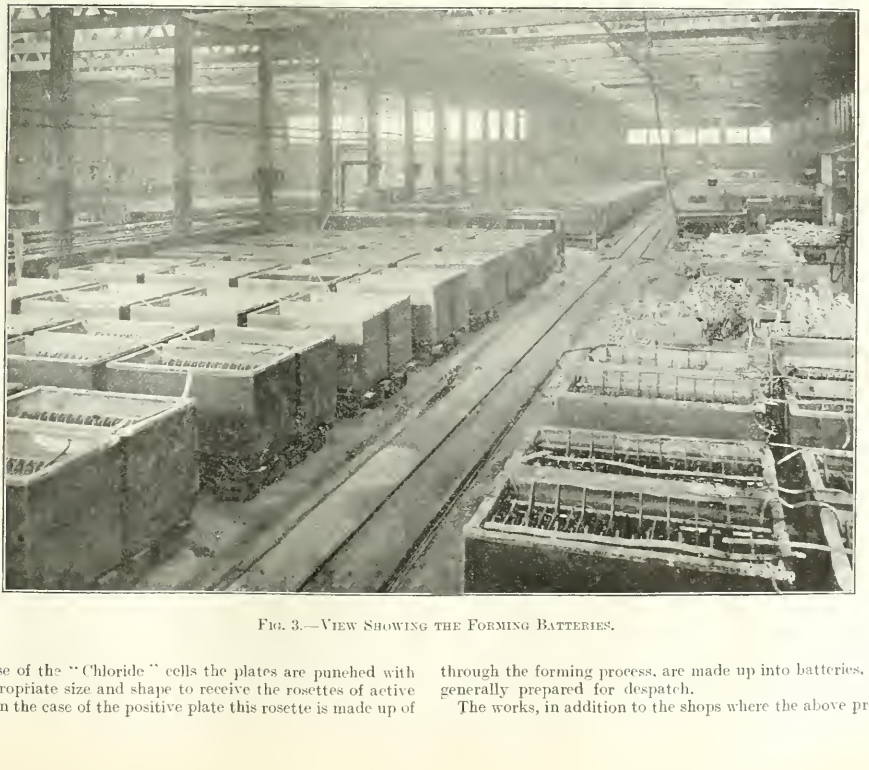


Fig. 3.—View Showing the Forming Batteries.

In the case of the "Chloride" cells the plates are punched with holes of appropriate size and shape to receive the rosettes of active material. In the case of the positive plate this rosette is made up of lead tape exuded from a press. This is passed through a gimping machine, where it is corrugated, cut and rolled up into the appropriate shape. The rosettes of both the positive and negative plates are forced into position in an hydraulic press. The plates then go through the forming process, are made up into batteries, tested and generally prepared for despatch.

The works, in addition to the shops where the above processes are carried out, contain sections devoted to tool making, joinery, testing and storage. They are fully equipped with all the most modern tools and machinery, but we heard the usual complaints of congestion; and, as a matter of fact, extensions are in contemplation. The necessary power for driving the works is provided from the mains of the Lancashire Electric Power Company, with the original power plant of the Chloride Company as a stand by. This is interesting historically as including a Mather & Platt vertical diagonal engine, of which only six were ever made. Canteens and recreation rooms are provided for the workers. Our illustrations give some idea of various parts of the works, which we must thank the Chloride Electrical Storage Company for giving us the opportunity of seeing.

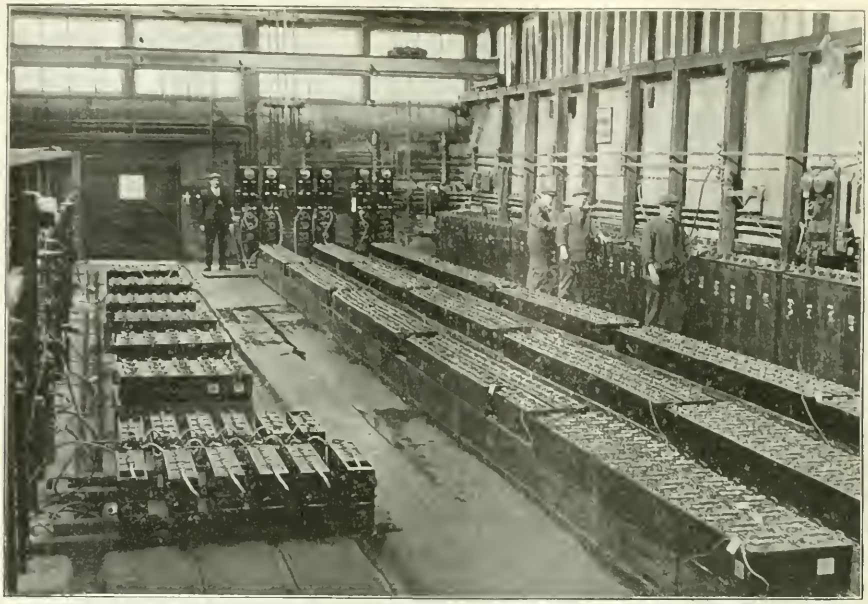


FIG. 4.—A CORNER OF THE TESTING SHOP.

British Industries Fair—Birmingham Section.

In our last week's issue we gave a general survey of this Exhibition which is now open at Castle Bromwich, near Birmingham. We now proceed to give particulars of some of the more interesting exhibits.

In connection with the British Industries Fair **THE GENERAL ELECTRIC COMPANY, LTD.**, have arranged at their showrooms (42, High-street) a special display of electrical plant and apparatus of a nature which will appeal to colonial and foreign visitors. In the re-arranged showrooms representative examples of the company's multitudinous productions are to be found, all carefully classified. These include such apparatus as small generators, motors, switchgear, fans, arc lamps, portable electric tools, &c. It is obviously impossible to exhibit samples of the larger machinery manufactured at the Witton Works, but to those interested the company is extending an invitation to visit the works, where the larger equipment for which the company is so well known may be seen in course of construction. Visitors will also be welcomed at Fraser & Chalmers' Engineering Works, Erith, Kent, where they can see in progress the manufacture of large steam turbines, conveying and mining machinery, winders and dry gas-cleaning plant.

Reverting to the display at the High-street showrooms there is a representative collection of telephones and telephonic gear, bells and batteries, while the exhibit of electric lighting fittings is most comprehensive. These fittings are the products of the Art Metal Works in Wheeley's-lane, whence came also the neat and adaptable "Slick" switches for lighting control. The G.E.C. "Magnet" electric heating and cooking apparatus is well represented by examples of ovens, cookers, boiling rings, self-contained utensils, irons, "Panel" fires, hot water radiators, the "Magnet" pedestal fires (which consume only 600 watts and can be used also for boiling, frying, stewing, toasting &c., and is the last word in portable heater design), the "Firenza" Fires, and many other items, &c. These are manufactured at the works in Moor-street, Birmingham. Other specialities include Chamberlain & Hookham meters, samples of cable made at the Pirelli-General Cable Works, Southampton, where facilities exist for the manufacture on the most up-to-date lines of cables from the heaviest submarine cable to the smallest insulated wire; arc lamps, and "Kinarko" carbons from the carbon works at Witton, "Salford" electrical instruments and circuit breakers, fuse and distribution boxes, Osram and Robertson lamps, magnetos made at Coventry by Conner Magneto and Ignition Company, and details of lift gear by the Express Lift Company.

Messrs. **SIEMENS BROTHERS & COMPANY** (Stand 22, Building A) are showing on their stand a selection of electric cells and batteries of various types, such as are manufactured by them at their Woolwich works. This exhibit includes the more generally employed forms of electric cells and batteries for the purposes of telegraphy, telephony, signalling, bell ringing and railway circuits, as well as for electro-medical apparatus, electric testing, and for supplying current for electric clocks, electric pocket lamps, torches, handlamps, toys, &c. Messrs. Siemens are also exhibiting electric incandescent lamps and lanterns, and reflectors for industrial electric lighting; holophane shades for domestic and office electric lighting; illuminated signs for both interior and exterior use; electric irons, kettles and radiators.

J. H. TUCKER & COMPANY, LTD., BIRMINGHAM. (Stand 44, Building A.)—Visitors interested in electrical accessories and switchboards will not fail to be attracted by the stand of this company, where is shown a very comprehensive range of samples of their various manufactures. A complete accumulator switchboard, of whose manufacture the firm make a speciality, for country house and similar lighting plant, besides numerous examples of fuse and distribution boards of varying capacities, both in teak and iron boxes, are shown as samples of the products of their switchboard and switchgear department. They also show a very complete range of switchgear components, such as switches, fuses, &c. Their ironclad fuses of various types and capacities, including a very complete range of apparatus complying with Home Office Regulations for industrial and other purposes, are also on view. As pioneers of tumbler switches they make a very special exhibit of tumbler switches in a variety of patterns and finished for all purposes. Another feature is a choice selection of switch plates for use with sunk switches, which are mounted in the firm's standardised boxes. General lighting accessories are also shown, such as lamp holders, cut outs, ceiling roses, wall sockets and plugs. A new design is the "Tucker" patent quick "make" and "break" ironclad switch, which is shown in two sizes—25 and 50 amperes and with and without double-pole fuses. The design of this switch case permits of it being used with either a large central tapped hole each end for the incoming and outgoing cables, or two smaller holes. This is effected by means of interchangeable and removable adapters, which can also be provided with recessed bodies and wood bushed holes for sealing hygroscopic cables.

DONOVAN & COMPANY, Birmingham. (Stand 20, Building A.)—"Safuse" and "Donlok" are now two well-known words in the electrical industry, and it is not surprising, therefore, to find on this stand a prominent display of "Safuse" and "Donlok" products in the shape of "Safuse" distribution boards, "Safuses," "Safuse" switches and "Donlok" combined switch wall sockets. The latter article is a unique combination, providing an absolute fool-proof and shock-proof plug and socket. Other interesting articles are Donovan's well-known "Barwick" motor starters and regulators, and a selection of electrical accessories. A special feature on this stand is a new conduit switch for which extreme simplicity in fixing and moving is claimed. The switch portion, as shown in our illustration (Fig. 1), is riveted to boxes and is earthed.

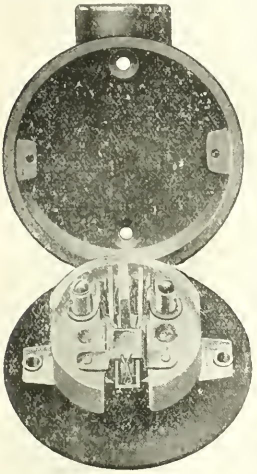


FIG. 1.—VIEW OF NEW DONOVAN SWITCH.

APOLLO MFG. COMPANY, BIRMINGHAM. (Stand 497, Building C.) To the electrical industry the most interesting exhibit on this stand is the Apollo electric horn. To most motorists this instrument is well known, but the company have realised that it can be applied to many other sections of industry besides the motoring section such as signalling, time buzzers, and other uses where loud warnings are occasionally needed. The apparatus is simple, but very efficient. It consists of three main pieces, the trumpet, to which is fixed a diaphragm, the relay, which works on the principle of the electric bell, and the cover. The relay is fitted on a brass mounting which is provided with a screw thread, and is screwed into the back end of the horn portion just behind the diaphragm. It will be obvious that the distance of the little hammer in the relay from the diaphragm regulates the pitch of the note, and a method is provided for binding the thread on to the relay mount at any desired position to obtain either a high note or a low note as required. The horns are made in three sizes, of which Fig. 2 is an example.

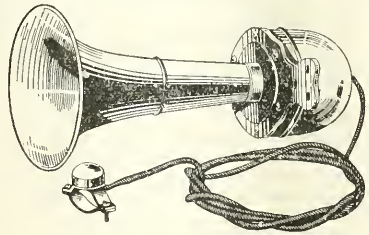


FIG. 2.—VIEW OF APOLLO HORN.

(To be concluded.)

Heating and Cooking Notes.

SUPPLEMENTARY ELECTRIC HEATING.

Where tariff charges for electricity are such that the heating of large buildings or houses entirely by electricity is ruled out on account of cost, it is often possible to add to the efficiency of the primary heating system by employing electric radiators to supply additional heat when required. The problem of designing a heating system for any given building or set of rooms is so complex owing to the many factors involved that it becomes practically impossible to install a simple system which will always maintain a given temperature, if the economical side of the question has to be considered. The ventilating system, or lack of it, the type of floors and walls, the purpose for which the building is used, together with the erratic climatic conditions that exist in this country, are all factors which materially effect the quantity of heat required to maintain the atmosphere at a given temperature. Therefore the provision of a primary heating system, either by using steam, hot water or hot air, which under ordinary circumstances will provide sufficient heat, coupled with an auxiliary heating system available when cold weather is experienced, is an economical method. The primary system will suffice during ordinary weather without overheating, and a consequent necessity of wasting heat by opening doors and windows to reduce the air to a comfortable temperature; whilst in cold weather the auxiliary electric heating system supplies an easily controlled means of obtaining just that degree of additional warmth that comfort requires. The chief disadvantage of the hot-water or steam system is the difficulty of easy control, and this is one of the advantages of electric heating. Take buildings that are shut from dinner time on Saturday until Monday morning, and where the heating system is started up again only two hours before the building reopens. The rooms are chilly as a general rule, and sometimes bitterly cold until lunch time or later on the Monday, with the result that illness occurs amongst the staff, causing loss of time and reduction of output. A supplementary heating system would remedy this nuisance, and would also help in connection with many existing heating systems which are inadequate during cold weather.

In addition to heating offices, there are many trade processes which have to be carried out at an even temperature, and also goods which require to be stored and maintained at an equable temperature. For such places this system possesses marked advantages. A series of electric radiators connected up under thermostatic control will ensure that if the temperature falls owing to atmospheric conditions, the electric radiators will come into action until such time as the temperature has returned to the predetermined level. To have boosted up the primary system by stoking would probably result in wasted fuel, due to too much additional heat being provided, and, further, there would be a considerable time interval before the desired additional heat was forthcoming.

NEW APPARATUS BY CREDENDA CONDUITS COMPANY, LTD.

We have received some interesting particulars regarding further apparatus produced by CREDENDA CONDUITS COMPANY, LTD. "Creda" fires have for some time past enjoyed a reputation for reliability, and it is pleasing to note that the list of "Creda" apparatus has been extended to comprise sterilisers, hot-water boilers, toasters and steel saucepans, in addition to kettles, irons and radiators, which we recently described. The table toasters are made in two types: a plain style, with vitreous enamel finish, suitable for use where price is a consideration. But as a table decoration we should prefer the model finished in nickel plate, although this im-

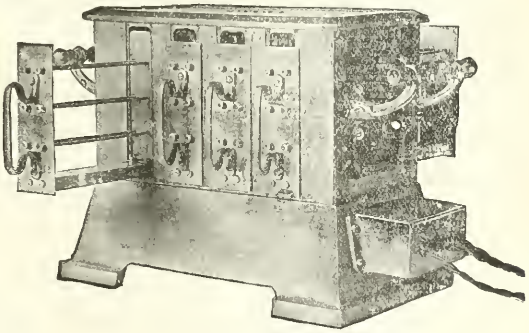


FIG. 1.—"CREDA" MULTIPLE TOASTER.

proved finish and general style has to be paid for. There is also a multiple type of toaster, which we illustrate in Fig. 1. This is intended for use in restaurants and hotels. It has a consumption of 2,250 watts, and an output of 250 pieces of toast per hour. For this purpose a piece is a slice across the loaf. A still larger size is made which consumes 4,050 watts and toasts 550 pieces per hour. The apparatus is strongly made and well finished in nickel plate.

The largest water boilers are made in heavy gauge copper, either finished polished or nickel plated, and range in size from 1 to 4 gallons, and in consumption from 1,050 watts to 2,800 watts. The elements are self contained, and are mounted in the base, together with two tumbler switches, to provide a means of obtaining heat control. The smaller boilers are of tinned sheet steel, the bottoms being welded in. Here, again, the elements are self contained and mounted in the base, but heat control is obtained by means of plug connections, the terminal pins being placed at the bottom of the side of the boiler. There are three sizes 4, 8 and 10 pints—consuming 850, 950 and 1,200 watts respectively.

The saucepans are also of sheet steel, with welded joints and plug control for heat regulation. They are made in three sizes—2, 4 and 6 pints respectively.

The "Wigmore" Electric Kettle.

The particular feature of this kettle in comparison with the ordinary type is that the element is arranged in the form of a tube, around which the water circulates. There is no necessity to employ a false bottom to contain the element, and therefore the size of the kettle for a given capacity can be smaller. Either polished copper or nickel plated finish can be had, and there are four sizes—2, 3, 4 and 6 pints respectively. In the smaller size of kettle, which will hold two pints of water and consumes 500 watts, we think it would have been an advantage to provide feet mounted on the base, because such a kettle can then be supplied from a lamp-holder, and it is often convenient to place it on a bedside table or shelf. The heat of a boiling kettle is quite sufficient to spoil the surface of a polished table, and it is inconvenient at times to fetch a mat or tray, to put the kettle on. In larger size kettles this is not so important because plug connections are needed, which means that the kettle will probably be used in the kitchen, where a suitable stand for the kettle can be provided. Fig. 2 shows the general appearance of this piece of apparatus.

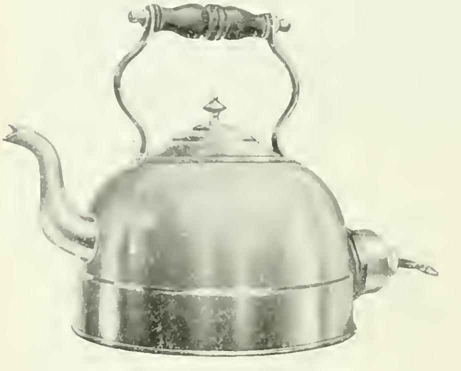


Fig. 2.—The "Wigmore" Electric Kettle.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on eceipt of published price, plus postage.]

"Le Courant Alternatif Generalités, Bobines et Transformateurs Stratiques Lignes de Transmission." By R. Swyngedauw. (Paris: Librarie Polytechnic Ch. Beranger.) Pp. iv.+564.

"Calcul, Construction et Essais d'Une Dynamo a Courant Continu." By F. Legre and P. Beauvais. (Paris: Librarie Polytechnic Ch. Beranger Pp. vii.+385.

"The Motor Mechanics' Handbook." By G. W. Watson and F. H. Rogers. (London: Cassell & Company.) Pp. viii.+267. 3s. 6d. net.

"Diesel Engine Design." By H. F. P. Purday, B.Sc., A.C.G.I. (London: Constable & Company.) Pp. xvi.+301. 21s. net.

"The Telegraphists' Guide." By James Bell & S. Wilson. Eighth Edition. (London: S. Rentell & Co.) Pp. xv.+258. 5s. net.

Telephonic Transmission, Theoretical and Applied." By J. G. Hill. (London: Longmans, Green & Co.) Pp. xvi.+398. 21s. net.

Correspondence.

RECENT ADVANCES IN THE UTILIZATION OF WATER POWER.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of the 6th inst. you were good enough to refer in your editorial notes to the Paper on "Recent Advances in the Utilization of Water Power" which I recently read before the Institution of Mechanical Engineers, but I think that some of your remarks call for comment on my part.

In the first instance, I would like to point out that the object of the Paper was to give a *résumé* of the recent improvements in the mechanical and hydraulic equipment of hydro-electric stations, particularly, in view of the interest now being taken in development of water power in this country and the absence of sufficient technical data on this subject in our current Technical Press. Hence, it was not claimed to add to the existing knowledge but merely to record in a concise form the most important developments up to the present date, to be of special interest to those whose time does not permit a detailed study of the subject. With regard to the figures given in the Paper relating to the available water powers in the principal countries in Europe and America, it was stated in a footnote that the estimates referred to the year 1915, and are, I believe, the latest official records on this subject.

Apropos Mr. Britton's article on the possible hydro-electric development in this country (*see* the same issue of The Electrician) you state that I am optimistic "about what will be done." I am not aware that I have expressed any opinion on the matter, although I strongly urged the necessity of devoting attention to our water pawer resources in connection with the establishment of new industries, having particularly in mind the vast resources or water power available in the Empire, for the development of which capital must be found in this country. On the other hand, I agree with you that however small as compared with other countries in Europe, there is obviously plenty of room in this country for water power developments.

Mr. Britton deals most ably with the subject from his point of view, which to a great extent is directed by local interests and the prospective developments on the River Dee. He seems to discount the value of the water powers in the Highlands for industrial purposes. I am afraid it is necessary to take a very much broader view of the position. The Committee on our water power resources in their interim report pointed to several schemes in Scotland, where about 200,000 h.p. can be immediately and economically developed. Before the war a large amount of British capital was attracted to Norway for the manufacture of aluminium, calcium carbide and nitrogen. In each instance cheap electric power is essential for the economic manufacture of these products, which, combined with a continuous manufacturing process and a high load factor, makes these industries most favourably suited for water power utilization. In Tasmania, the Hydro-Electric Department of the Government has recently taken large interest in the electrolytic production of zinc, and it is estimated that within the next few years nearly 1,000 million units per annum will be required for this industry alone. It is no doubt recalled that the zinc industry at the outbreak of the War was to a great extent in the hands of Germany, and of a total consumption of 260,000 tons in this country, over 200,000 tons had to be imported. We have large deposits of zinc ores suitable for electrolytic or electro-thermal treatment and the utilization of water powers in this connection is of the greatest national importance.

Without exception, the industries cited above can be considered as key industries, and I submit that attention should, in the first instance, be directed to developing our larger water powers in connection with such industries requiring cheap electric power and the establishment of which is an urgent national necessity. It is in this connection that aid from the Government should be invoked and a constructive policy adopted designed to promote under private control the immediate development of our water power resources for the purpose of making this country less dependent than hitherto on foreign supplies as regards the most important key industries.

I agree entirely with Mr. Britton that attention to the small water powers should not be lost sight of, but I am of the opinion that with the present high cost of coal, Municipal Corporations and private interests are fully alive to the advantage of water power where an economical development is possible, so that the utilization of our numerous smaller water powers can safely be left to private enterprise.

You rightly refer to the "bugbear" of vested interests, but in countries where water power has been developed on a national basis special legislation has been passed for the purpose, and the present Government intends to present a Bill in this session which it is hoped will remove many of the obstacles experienced in connection with our water power developments.

In conclusion, I trust you will lend the aid of your powerful journal in the interest of promoting the development of our water powers.—I am, &c.,

London, Feb. 17. ERIC BERGSTROM, A.M.I.Mech.E.

FOWLER'S BATTERY RULES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Mr. Dunton's letter in your issue of the 13th, criticising the battery grouping rules given in Fowler's Pocket Book, your correspondent appears to have made several errors, and at the least his arithmetical substitution would need some explanation!

Using the same notation as your correspondent, we have the "bad" rule

$$\frac{r \, . \, s}{p}=R. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (1)$$

This is merely the algebraic representation of the statement that the internal resistance of the battery should equal the external resistance, and as an equation is *insolvable as it stands*, since it contains two unknown quantities, s and p. These are connected, however, by the fact that

$$s \, . \, p=N,$$

hence

$$s=\frac{N}{p} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (a)$$

and

$$p=\frac{N}{s}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (b)$$

By substituting the value of p in equation (1) we have

$$\frac{r \, . \, s}{\frac{N}{s}}=R,$$

or

$$\frac{r \, . \, s^2}{N}=R,$$

hence

$$s^2=\frac{NR}{r}$$

and

$$s=\sqrt{\frac{NR}{r}}. \quad . \quad . \quad . \quad . \quad . \quad . \qquad (2)$$

Thus the "worse" rule is the same as the "bad" one. By substitution for the value (a) of s we obtain a third equation

$$\frac{r \, . \, \frac{N}{p}}{p}=R$$

$$\frac{rN}{p^2}=R$$

and

$$p=\sqrt{\frac{rN}{R}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (3)$$

In view of the foregoing, it would be interesting to know how two entirely different results have been obtained on substitution of the values quoted as a numerical example. As equation (1) is insolvable in the form quoted it might be imagined that one factor had been guessed, and one is tempted to wonder what figures would have been arrived at had the value of N been 13 or 24, giving a more limited or more liberal choice of factors! Also, with the figures quoted—namely, $N=26$, $r=1$, $R=3$—how is it determined that $s=13$? Is it from the second rule (equation (2))? By this rule

$$s=\sqrt{\frac{NR}{r}}$$

$$=\sqrt{\frac{26 \cdot 3}{1}}$$

$$=\sqrt{78}$$

$$=8{\cdot}83.$$

Hence

$$p=\frac{N}{s}$$

$$=\frac{26}{8{\cdot}83}$$

$$=2{\cdot}95.$$

Surely these figures would prompt one to investigate the possibilities of a grouping of three parallel lines of nine cells each before looking farther. As, however, we are one cell short of $3 \cdot 9$, the grouping of three lines of eight cells each is surely the most logical!

When R is changed from 3 to 2 I fail to see how rule (2) gives a value of $s=2$.

For

$$s=\sqrt{\frac{NR}{r}}$$

$$=\sqrt{\frac{26 \cdot 2}{1}}$$

$$=\sqrt{52}$$

$$=7 \, . \, 21$$

and

$$p=\frac{26}{7 \, . \, 21}$$

$$=3{\cdot}6.$$

These figures I should take to indicate three lines of seven cells each or four lines of six cells each as the nearest practical groupings. Taking the first suggested grouping, we have

$$C_3=\frac{7e}{\frac{7\times1}{3}+2}=\frac{7e}{4\frac{1}{3}}=1{\cdot}615e.$$

The second suggested group gives

$$C_4=\frac{6e}{\frac{6\times1}{4}+2}=\frac{6e}{3{\cdot}5}=1{\cdot}71e.$$

Hence the best grouping would be four parallel lines of 6 cells each. Comparing this with the "interpretation" of rule (2), given by Mr. Dunton, in which we have either 13 lines of two cells or two lines of 13 cells,

$$C_{13}=\frac{2e}{\frac{2\times1}{13}+2}=\frac{2e}{2\frac{2}{13}}=0{\cdot}93e$$

and

$$C_2=\frac{13e}{\frac{13 \cdot 1}{2}+2}=\frac{13e}{8\frac{1}{2}}=1{\cdot}52e.$$

Following on his criticism of Fowler's rules, your correspondent evolves a formula of his own for determination of the best grouping of cells, the result achieved being that maximum current is attained when

$$p=s \, . \, k$$

where k represents the ratio of $\frac{r}{R}$.

Hence the condition is fulfilled when

$$p=\frac{s \, . \, r}{R}.$$

What is this, pray, but the "bad" rule given in Fowler, merely with the terms transposed?

$$p=\frac{s \, . \, r}{R},$$

or

$$R=\frac{s \, . \, r}{p}.$$

Again, it does not appear to be of any special interest to bring in the question of " cells " which are not cells, but groups of cells, as in " high voltage cells." The point to remember, then, when applying these formulæ is that the figures for E.M.F. and internal resistance per cell must be taken as the figures of the smallest group which we can or are prepared to come down to. Thus, with three cell groups of dry cells, if all the terminals are accessible for connections, and they are merely made into mechanical packages or group of three cells, we consider *e* and *r* as for one cell. The same applies if they are connected up solidly, but we are prepared to break them assunder for the special needs of the situation. On the other hand, if made up, say, solid in groups of three in series, and we do not wish to break down to component cells, then the value of E.M.F. and internal resistance to be considered is that of the *complete group*. I am, &c.,

Redcar, Feb. 15. A. LISLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Dunton, in his letter in your issue of the 13th inst., *re* the above, has substituted a solution having two unknowns, for one having only one unknown, in order that he may get an arithmetic mean of two possible solutions to act as the determining factor instead of a geometric mean. There is not much objection to two unknowns in an arrangement having only four possible solutions (only two of which Mr. Dunton finds it necessary to consider), but with 24 cells, for instance, it appears much preferable to have an equation having only one unknown, when the answer can be immediately arrived at, bearing in mind that it is the geometric and not the arithmetic mean which is the determining factor as to which is the nearest solution.

If Mr. Dunton would put his solution into a form having only one unknown, while retaining the advantages of an arithmetic mean which appears to be so desirable as the determining factor, we would arrive at the best possible solution.—I am, &c. R. MERCER.

Liverpool, Feb. 17.

THE THERMIONIC VALVE AND ITS DEVELOPMENT IN RADIOTELEGRAPHY AND TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with more interest than surprise the letter in your issue of Jan. 9 by Marius Latour, protesting against failure on the part of Prof. Fleming to give to him or other French engineers due credit for early work in developing the mathematics of the audion, or for certain types of amplifier circuits. M. Latour being doubtless familiar with Prof. Fleming's treatment of the triode and its inventor through past years in multitudinous books, papers and communications on the subject has no justification whatever for being " extremely surprised that he (Fleming) does not mention any French name, &c."

In a compendious tome published in 1910, " The Principles of Electric Wave Telegraphy, &c.," ostensibly the effort of an authority to lead readers by the paths of truth, Prof. Fleming bequeathed to posterity in fine typed footnote the following gem:—

> " As a radio-telegraphic oscillation detector precisely similar, or else closely resembling (sic), the author's oscillation valve above described has been denominated by Lee de Forest an *audion*, and claimed by him as a novel invention of his own, it may be well *in the interests of scientific history* (italics not his) to recapitulate the facts on which the author relies in support of his own priority of invention."

This book was written " before the war." But it seems there has appeared another book, by the same hand, equally fair, equally impartial, and trustworthy. " My book," Prof. Fleming now informs M. Latour, " was written . . . before the Armistice was declared, . . . It was necessary, therefore, for me to exercise a certain discretion in reference to apparatus in actual use in the field of war "—" a certain discretion " with which Prof. Fleming has had many years of apt familiarity!

No—I maintain that Prof. Fleming is right: M. Latour has no excuse for his extreme surprise. It is nevertheless refreshing to learn from his own words that an author a writer not ostensibly of friction, but a recorder of scientific fact, for the instruction of students and seekers after knowledge " shall retain the right to private judgment in the selection of his material." How reliable and trustworthy such private judgment can sometimes be may be gauged by the radio engineer of to-day who compares the above footnote from Fleming's book before the war with the following by Dr. Eccles in the October issue of the " Radio Review ":—

> " During the war a revolution was taking place in wireless telegraphy, the principal agent in which was reported to be an instrument called a ' valve,' or a ' tube.' It must be emphasised that it is the three-electrode valve, and not the valve with two electrodes, that has been responsible for the overthrowing of the old methods and apparatus."

Dr. Fleming assures M. Latour that his object " was to give as lucid a description as possible of the development and operation of the thermionic valve." Words can go no further.

I am, &c., LEE DE FOREST.

New York, Jan. 29.

LOSSES IN TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his letter in your issue of the 20th instant, criticising my article on the above subject, Mr. William C. Kennett says " the suggestion that purchasers should specify the ratio is a particularly mischievous one." I quite agree. In my article I expressly said " What ratio of losses is best for a given case depends . . . on points connected with the design of the transformer which are known to the manufacturer." Instead of suggesting that the purchaser should specify the ratio of losses, I suggested that the purchaser should specify a formula by which the manufacturer can determine what ratio of losses will at the same time be most conformable with his own design, and best meet the requirements of the purchaser. I do not think that the best transformer, from every point of view, is obtained if the ratio of losses is left to the manufacturer, while he is left in ignorance of the circumstances which determine the most economical ratio of losses.

The chief transformer designer of one of the largest manufacturers in the country has told me that he is in the habit of supplying transformers with a higher ratio of losses for the Dutch Market than for the British Market, which makes me believe that manufacturers do not always design the ratio of losses up to the limit of safety. If the purchaser specifies the transformers according to my formula, he will be able to place the order with that manufacturer who can guarantee the safe working of the transformer under load and short circuit conditions with the most economical ratio of losses.

With reference to the last paragraph of Mr. Kennett's letter I fail to see how a statement of the purchasers requirements can operate against standardisation. The formula I suggest would not prevent the manufacturer from putting forward a standard design. It would merely favour the manufacturer whose standards came nearest to the purchaser's requirements. Therefore, if purchasers were in the habit of specifying the losses as suggested, the tendency of makers would be to adjust their standard types accordingly.—I am, &c.,

London, Feb. 21. REGINALD O. KAPP.

WIRELESS TELEGRAPHY AND TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On page 150 of the 1917 edition and also in the 1915 edition of Dr. Eccles' well-known " Handbook " a formula appears, which is known in America as Eccles' Law of Transmission. It implies that the power needed for radio transmission is proportional to the sixth power of the distance. This is not proved by the author, but works out well with the spark. Will the author explain and say how modern tube reception affects it?

On page 129 of the second edition and also in the first edition is a formula of antenna resistance also unproved. It is a successful law but no explanation is known to those I have asked. Would Dr. Eccles give a proof or a reference to a proof.—I am, &c. TRAVELLER.

The Electrician.
FRIDAY, FEBRUARY 27th, 1920.
Price SIXPENCE. By Post 7d. Ann. Sub.: U.K. 28s., Abroad 30s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

The Trend of Electrical Education.

The development of the use of electricity for all purposes along progressive lines will depend more and more on the human factor. Scientific invention will no doubt play its part. Increase in our knowledge of economic facts will prove of undoubted utility. Propaganda will find its uses. But the controlling factor will be the knowledge and acumen of that very human person, the electrical engineer of the future. The question, therefore, arises: Are those numerous students now going through courses at our universities and technical colleges—students who will, of course, be the electrical engineers of the future—being taught in a way that will develop those essential qualities which we have just mentioned?

Engineering Knowledge not Everything.

From certain pronouncements which have recently been made on this subject one point emerges upon which there is general agreement. This is that engineering knowledge must not be the be-all and end-all of the education of an engineer who wishes to rise to the top of the profession. This point of view has been put forward in different ways. Mr. Roger T. Smith in his presidential address to the Institution of Electrical Engineers was a little regretful of the fact that the chief engineer of a large undertaking is nowadays mainly concerned with questions which have little to do with engineering. Prof. E. W. Marchant, in an address to Liverpool Sub-Centre of the Institution, though optimistic about the ever-increasing demands for electrically trained men, pointed out that knowledge which would enable the potential engineer to deal readily with commercial problems was also essential. In an address to the East Midland Sub-Centre of the Institution of Electrical Engineers Mr. F. S. Grogan stated that the education of the boy who is to become an engineer should be given a definite trend as soon as possible. He should be taught scientific subjects on broad lines and attend an engineering course at a technical school. But after having done all this then comes the most difficult part of his career. He has got somehow to find work without being in possession of knowledge which is of much direct use in commercial life. But while he admits this as an undoubted fact, it would in Mr. Grogan's opinion be unwise to add the study of Company Law and works and sales organisation to the curricula of the college course. If the embryo engineer brings with him from college an adequate knowledge of fundamentals all these other things will be added to him as he goes along.

The Importance of Both Views.

These three views are interesting. Not because they are different, but because we find the teacher insisting on the importance of theoretical instruction in commercial subjects and the business man putting forward the view that these things can be picked up as the student goes along. The reason for this is not we think obscure, for the fact surely is that the business knowledge which it is necessary for the engineer to acquire can not only best be learnt, but can only be learnt at the desk or in sale rooms of a commercial concern. This point of view is well brought out by a writer on "The Commercial Career" in a recent issue of "Ways and Means," who is, of course, dealing with the commercial career generally, and does not refer specifically to technical training. Nevertheless his words have their application. The question he asks is this: Is the commercial course intended to make clerks or business men? The "usual things," shorthand, typewriting, and even Company Law, will only do the latter, and it is around this mere routine of business that a great deal of commercial education seems to be building. Such instruction may, of course, do more harm than good in that it tends to retard the development of excessive ability. Business, the writer concludes, is applied psychology, and requires a diligent apprenticeship over and above what a clerk in an ordinary business house is usually able to obtain owing to the need of specialisation under modern conditions of working. Most electrical engineers who had perforce to take up business will agree with this view.

Two Schools of Thought.

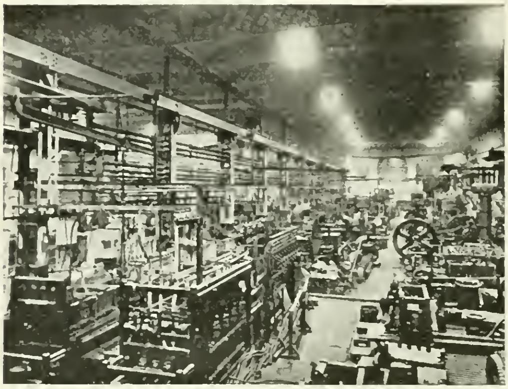
There are, therefore, it seems, at least two schools of thought on this subject; one that thinks commercial subjects can well be taught in a college course and the other which thinks a knowledge of business can only be picked up in business surroundings. As far as the electrical engineer is concerned we think the latter is the right course, and that the other view has been put forward because the part that the electrical engineer plays in business is not altogether clearly realised. The electrical engineer becomes a business man just because he is an engineer, and acquires his knowledge of business details as he goes along as a necessary adjunct to his engineering knowledge. His engineering knowledge, it may be said, is the motor and his business knowledge the current which drives it, or the simile is just as good or as bad when put the other way round. No motor can drive machinery without a supply of current. Nor can the current, though possessing the potential energy, drive machinery without a circuit and coils through which to do it. The fact that an engineer states that he makes little use of his engineering knowledge in his work should be taken that he does not use it much consciously—not that it is not there or that he could get on without it. It is ready for use in emergency when the lack of it would be immediate results of an unfortunate character. The same cannot be said of the business knowledge. In engineering, for the engineer, though useful, it is not fundamental. And as Mr. Grogan points out, it is always possible for an engineer to get expert advice in these questions. Without wishing to be unduly cynical it may be remarked that knowledge is not so much knowing a thing as knowing where information about it is to be found.

Specialisation in Fundamentals.

We therefore agree with Mr. Peck that engineering education should be directed to specialisation in fundamental principles. They are a sure foundation on which to build, and at least there is no doubt that the proper place to teach them is in a technical college. With a good knowledge of fundamentals no engineer can go far wrong, and in this age of specialisation he must leave it to chance almost what he makes the chief subject in which he works. In our view the tendency in all educational institutions should rather be towards a decrease than an increase in the subjects taught, and a concentration of instruction on those which underlie everything. To do this would ensure a sound foundation on which any structure might subsequently be built with fair chances of success.

The Lighting of Messrs. Belliss & Morcom's Works.

The recent reorganisation of the electric lighting installation at Messrs. Belliss & Morcom's works, Birmingham, provides an extremely interesting example of modern practice in industrial illumination. For some time it has been apparent that the old plan of having the lamps near the work could be improved by using a more general system of lighting. The aim in the new installation has been to provide adequate and uniform illumination throughout the various shops, quite irrespective of the positions of machines or benches. The lighting equipment consists of Mazda half-watt type lamps in Mazdalux metal reflectors of the focussing type. In the erecting shop, for instance, 22 500-watt units are suspended 28 ft. above the floor. The machine shop contains 20 500-watt units at a height of 38 ft., while in the foundry there are 16 300-watt units fixed 25 ft. 6 in. above the floor.



Messrs. Belliss & Morcom's Erecting Shop Lighted by 22 500-watt Mazda Half-watt Type Lamps in Mazdalux Reflectors.

The photograph which we reproduce was taken by the light of the Mazda units, and has not, we understand, been re-touched in any way. The illumination, is, it is claimed, far and away above the usual standard of factory lighting, and in many respects it is similar to good daylight—that is, it is fairly uniform over the whole working area, there are no harsh shadows, and there is a total absence of glare and dazzle.

A Cheshire Electricity Authority.

An important conference of local authorities of Cheshire and Flintshire, convened by Chester Corporation, was held at Chester last week to consider the formation of a joint electricity authority.

The Mayor of Chester, who presided, said the object of the conference was to see whether they could arrange a district extending from Tarvin, in Cheshire, to Mostyn, on the Welsh coast, and back to Rossett and Caergwrle. He believed the ultimate scheme was to have a grouping of districts round the North Wales power station, which would be served by it and be linked to it. If they could supply cheaper electricity to the area it would have an enormous effect on the prosperity of the district.

Mr. Noel Humphreys, Chairman of the Chester Electricity Committee, who explained the proposed scheme, said the inception of it was in no way concerned with the aggrandisement of Chester Council. That city happened to be the only authorised undertaker in the area; it was the chief centre of population, it was the only authority in the area which operated an electricity station. The aim of the Electricity Act was the serving of large areas, and the country was being divided into large districts, which it was proposed should be subdivided into smaller electricity areas operated by joint electricity authorities. So far as they were concerned, the large area would be one embracing all North Wales and part of Cheshire, in conjunction with the hydro-electric stations of the North Wales Power & Traction Company. In July last Mr. S. E. Britton, electrical engineer to the City Council, was invited by Sir John Snell, Chairman of the Electricity Commissioners, to indicate the most suitable area for the North Wales district, and, failing that, he was asked to convene a meeting of engineers of the various local authorities to discuss the most suitable subdivision to form an electricity district. In consequence of that the proposed district had been suggested as the most suitable area to be operated by a joint electricity authority. Within that area it was estimated there was a potential demand for 20,000 h.p., which would mean the consumption of 15 million units per annum.

Mr. E. Peter Jones, representative of Cheshire County Council, said that he was glad that their ideas were taking shape. He thought the North Wales coalfield would be a very good place to generate electricity. The whole of Wirral and the south bank of the Mersey could be supplied from North Wales.

Mr. Tilby, clerk to Flintshire County Council, thought that the formation of an electricity district was a matter for the Electricity Commissioners,—all they could do was to suggest the area.

Replying to points raised in the discussion, Mr. S. E. Britton said that Chester Corporation had got a definite offer of the use of the Queensferry works. A power station was about to be erected on the Mersey to supply both banks of the Mersey, including Birkenhead and Liverpool.

Ultimately it was agreed that further consideration of the proposed scheme be adjourned to a future conference, and that in the meantime the city of Chester should furnish each authority concerned with a reasonable statement of their proposals. Mr Britton is now preparing this statement.

Success of Railway Electrification.

Important announcements have recently been made by several of the Railway Companies in regard to the success of electric traction where it is in operation, and it is proposed to adopt the system on other sections of the lines. The Earl of Bessborough, who presided over the shareholders meeting of the London, Brighton & South Coast Company, stated that the traffic on their urban lines was very congested, and their great hope was in electrification. The relief obtained by the quicker working of electric trains was so considerable that if they could carry out the programme to extend the electrical services throughout the whole of their suburban area they could unquestionably greatly improve the travelling facilities. The problem was now engaging the attention of the Government. There had been a large growth of traffic not only in the suburban services, but also in those to the South Coast. Last year's passenger receipts showed an increase of £548,000 over 1918, but on the expenditure side there was an increase of £871,982.

Speaking at the meeting of the Lancashire and Yorkshire Railway Company on the same day Mr. E. B. Fielden said the directors were satisfied with the results of the electrification of the line, and they now favoured an extension of electrification between Manchester and Oldham, and on to Shaw and Royton. The proposed extension formed part of a complete scheme which was prepared some time ago. At the same time the directors did not think it was wise that they should suggest to the shareholders that they should sanction further large additions to capital. Unless the Government were prepared to find the capital, such pressing and financially promising developments as electrification and also the extension of the fish dock at Fleetwood, must remain in abeyance.

Sir Gilbert Claughton, Bart., who presided over the meeting of the London & North-Western Railway Company last week, also had a very satisfactory statement to make about the success of electric traction. He said the company had been able, in conjunction with the Underground Electric Railway Company, to run a more frequent service of electric trains between Watford, Queen's Park and Waterloo, and they hoped shortly to be able to put into that service several of the new trains which were being built for it. Judging from the ever-increasing number of passengers using the tube trains to and from their line, they might also confidently look forward to a largely increased traffic to Euston and Broad-street when they were able to run their full through services. Every effort was being made to complete the line and obtain delivery of the necessary additional rolling stock. The estimate of capital expenditure in 1920 included £150,000 for the widening of the line between Chalk Farm and Willesden for the electric service. The work is to be proceeded with and completed as early as possible in order to provide for the increased traffic. There is also an item for new electric trains for the service between London and Watford.

Brigadier General Hugh M. Drummond, C.M.G., who presided over the meeting of the London & South Western Railway Company on Friday last, also dealt with the question of the serious overcrowding in the suburban area. The overcrowding was due to three causes. The first was the enormous increase that had taken place and was still taking place—in those districts of their railway which had been electrified. In 1913 the number of local passengers carried in the area they had since electrified was 25 millions. Towards the end of 1915 they opened the first section of their electrified lines, followed at close intervals by other sections. Last year they carried over those sections just under 48 millions of passengers, an increase of 70,000 per day compared with 1915. While the traffic increased at an enormous rate, the equipment of the line remained at a standstill, and it would be some time before they were able to overtake the arrears brought about by nearly six years of stagnation. Another cause of the congestion was that the rush was now confined to a period of two hours in the morning and evening. It was difficult to see how they could relieve the pressure during the rush hours unless the big employers of labour and the workers themselves were willing to so alter the periods of commencing and finishing work as to enable the rush hours to be spread. In June last they gave an order for the conversion of additional coaches for strengthening the existing electrical services, but, unfortunately, the moulders' strike supervened and none of the castings which were ordered had yet come to hand. That would enable them to make up certain of their electric trains to eight coaches instead of six during the rush hours. So far as the overcrowding on the Waterloo & City Railway was concerned, they had determined to supersede the present electrical equipment by modern equipment, so as to increase the speed of the trains up the inclines. That would enable them to run 24 trains an hour instead of 20. They were also considering the question of extending their electrification to cover Guildford.

The Great Eastern Railway Company, which has not yet made any experiment in electric traction, is about to follow the lead of more progressive lines and the general manager (Sir Henry Thornton), in consultation with experts, has been instructed to prepare a scheme for the electrification of the urban lines of the company.

The Electricity Commissioners.

In our last issue we referred to the appointment of four commissioners under the Electricity Supply Act, and gave brief sketches of their careers. In addition, we were able to publish photographs of Sir John Snell, Mr. W. W. Lackie and Mr. A. Page; but we were unable to give one of Mr. Harry Booth, O.B.E., who had not been photographed for many years.

Mr. Henry Booth.

We are pleased to be now able to reproduce a photograph of Mr. Booth, who has since "undergone the ordeal."

In the House of Commons on Monday the Minister of Transport (Sir Eric Geddes) stated, in reply to a question, that in completing the Electricity Commission he would have special regard to the desirability of the fifth Commissioner being an expert in finance and with business qualifications.

Legal Intelligence.

Direct United States Cable Co. v. Western Union Telegraph Co.

Last week Mr. Justice Peterson resumed the hearing of the action (adjourned from November last for the production of evidence from America) relating to a dispute as to a 99 years lease of the plaintiff company's trans-Atlantic cable at a rental of about £60,000 a year. Plaintiffs under a covenant of the lease undertook to repair the lines and maintain through communication, power being reserved to determine the lease in the event of 18 months continuous interruption.

Mr. Maugham, K.C. (for defendants), said he proposed now to take the evidence from America as to the breaks which had occurred in the shallow water on the other side of the Atlantic, as he understood that some point was going to be made of the non-repair of those breaks. He would produce evidence as to the breaks between Rye Beach and Halifax, but inconvenience arose from the fact that he did not know what was the real issue between the parties.

Mr. Patrick W. Reib, superintendent of the station at Rye Beach, said that in the course of his duties he became aware of the loss of insulation in the Halifax section due to breaks or faults. One of the breaks occurred 428 miles from Rye Beach on Jan. 7, 1917, and another occurred on Aug. 8 of that year close to Halifax, but both of thme were repaired shortly afterwards. On Jan. 2, 1917, there was an interruption which was repaired on the 11th, but on Jan. 7, 1918, there was complete interruption which he localised at about 325 miles from Rye Beach. Then on the 9th another break occurred 93 miles from Rye Beach and from that date until July 29, 1919, it was not possible to use the cable between Halifax and Rye Beach. From time to time the company's ships repaired the breaks.

In cross-examination witness said that the repairs of the breaks in the Bay Roberts section were carried out by a French cable ship, but with that exception they were always carried out by his company's ships. The French ship in repairing other cables broke the defendants' cable by mistake and repaired it. The breaks in shallow water were frequently caused by dredgers and other vessels fouling the cables.

Mr. Joseph Brown, superintendent at Halifax, gave evidence as to the condition of the cables between Rye Beach and Halifax and Bay Roberts and Halifax, to the breaks spoken of by the previous witness and the time occupied on the repairs.

Mr. Reginald Carlton, president of the Western Union Telegraph Company, gave evidence of the general organisation of his company and said that the superintendents reported directly to him, and amongst the most important matters reported were the repairs of cables the expenditure in relation to which being very heavy. There were three repairing ships leased to the company which were engaged in repairing the cables. In 18 months there were seven breaks, all of which were repaired by the company's ships. During 1918 they had no ships to repair the Halifax-Rye Beach section without sacrificing other much more important work.

Witness was cross-examined by Mr. P. Hastings, K.C., with a view to showing that the Western Union were desirous of leaving the interruption to continue for 18 months so that they might be in a position to put an end to the contract.

Further evidence was given and the case was adjourned.

Hodges v. Webb.

On Friday last Mr. Justice Peterson gave his reserved judgment in this action for an injunction to restrain defendant from wrongfully interfering, or attempting to interfere, with his (plaintiff's) employment and his right to dispose of his labour as he willed. The facts of the case and the evidence were reported in The Electrician for Jan. 16 and 23.

In giving judgment, his Lordship, after reciting the facts, said that in his opinion what happened at the interview between plaintiff and defendant at Delectaland on Oct. 13 was that defendant asked plaintiff to join the E.T.U., that plaintiff refused and that defendant then told him that he would have to call the men off the job and that they could not return unless he (plaintiff) was off the job. Defendant then went to the men and told them that as plaintiff refused to join the E.T.U. he had no option but to ask them to cease work. On the evidence he refused to believe that at that interview or the subsequent one, defendant made a threatening gesture. With regard to plaintiff's allegation that defendant threatened to take away his livelihood if he did not join the E.T.U., his Lordship came to the conclusion that plaintiff's memory of the words used was not to be trusted. On the whole evidence he came to the conclusion that the words complained of were not used, but defendant did tell plaintiff that if he did not join the E.T.U. the same trouble would occur on any job on which he was employed. The men were called out because plaintiff refused to join the E.T.U. There was no suggestion that defendant induced any breach of contract between the employers and the workmen, nor was there any allegation of conspiracy or unlawful combination. It was impossible to hold that Messrs. Tyler & Freeman were induced to dismiss plaintiff by any statement made by defendant to plaintiff, for there was no evidence that any such statements were reported to Messrs. Tyler & Freeman. Defendant had full autbority from his union to call upon the members of the union to cease work. No one doubted that the men could have ceased work because they objected to working with plaintiff or were entitled to refuse to return to work under the plaintiff. On the evidence it was impossible to find any threat which was a sufficient basis for an action, and consequently sec. 3 of the Trades Disputes Act, 1906, did not apply. Workmen were entitled to cease work for any reason, good, bad or indifferent; and employers were entitled to decline to continue certain workmen in their employment for any reason, good or bad. It would be very strange that while workmen could cease work, they could not in a body or by one of themselves, or by one of the officials of their union inform the employers of the fact that they proposed to cease work and of their reasons for doing so without risking being sued for using threats or coercion. The mere statement of men that they intend to do something they were entitled to do could not be a threat. If defendant had called out the men without speaking to plaintiff, the plaintiff would have had no action against him, and his Lordship was not prepared to say that because defendant said that he would do something which he had a lawful right to do, there was such a threat as rendered defendant liable in an action by plaintiff.

The action was, therefore, dismissed.

The Cardiff Local Advisory Committee of the Electrical Trades, Benevolent Institution (Messrs. Chamen, Howard Fletcher, Hobbs, MacTaggart and McWhirter), having realised the difficulty of getting the younger members of the industry to attend an ordinary meeting with the object of getting new members of the Institution, organised a successful concert, provided entirely by the "G.E.C. Magnets," which took place on the 17th inst. in the G.E.C. showroom, Castle Arcade, Cardiff, and produced good results both in recruits and pecuniary support.

Commercial Topics.

Electrical Catalogues for Mesopotamia.

The Department of Overseas Trade announces that the superintendent of stores of the Mesopotamian Railways has asked for copies of British manufacturers' catalogues dealing with electrical plant and accessories. The request is made, not only for his own guidance, but with a view to stimulating a general demand for electrical supplies.

* * * *

Electrical Progress in Peru.

Like most South American countries, there is an increasing tendency to introduce electricity supply and to adopt the electric drive in works, sugar mills, &c., in Peru. There are some hydro-electric works in operation, and efforts are being made to develop others. Oil and gas-driven sets are also in demand, and, as British supplies are popular, there should now be a good market for all electrical goods, including generating sets, storage batteries, carbons, electric motors, ventilating fans, insulators, lamps, meters, telegraph and telephone apparatus, wire and cable, electric bells and accessories.

* * * *

New Zealand Electrical Supplies.

There is so much activity in electrical circles in New Zealand that there is a very brisk demand for electrical plant, motors and supplies of all kinds. Good progress is being made with the development of the Government hydro-electric schemes at Hora Hora and Lake Coleridge, while plans are being prepared for the erection of hydro-electric works at Waikaremoana and for electric transmission lines to Gisborne, Napier, Wairarapa, and to the South Island. It is, therefore, not surprising to learn that all local supply stations are providing for extensive increases in the capacity of their installations, and the demand for machinery, particularly for the development of water-power, is especially urgent.

* * * *

Smoke Abatement.

Electrical engineers will be interested in the announcement that Dr. Addison, the Minister of Health, has appointed a Committee to consider the present state of the law as regards the pollution of the air by smoke and other noxious vapours and to advise what steps are desirable and practicable to diminish the evils still arising from such pollution. It will be remembered that a Departmental Committee was appointed in 1914 to inquire into the subject and it had made some progress in taking evidence when the war interfered with its proceedings.

The Committee is a fairly good one, but it might very well be larger and more representative. One of the most effective remedies for the smoke nuisance is the more general adoption of the electric drive in factories and workshops, and the introduction of electric radiators and heaters for domestic heating, and for this reason we should have liked to see an electrical engineer on it.

Lord Newton will be chairman of the new committee, and the other members are Capt. Hamilton Benn, C.B., D.S.O., M.P.; Prof. J. B. Cohen, F.R.S. (Leeds); Mr. U. S. Curphey, Chief Alkali Inspector Ministry of Health; Sir John Lithiby; Mr. J. F. MacCabe, D.S.O., L. G. Board, Ireland; Mrs. G. Samuel, O.B.E.; Mr. E. D. Simon (Manchester); Bailie W. B. Smith (Glasgow); and Mr. F. J. Willis, C.B., Chief Assistant Secretary, Ministry of Health. Mr. E. C. H. Salmon, will act as secretary and communications should be addressed to him at the Ministry of Health, Whitehall, London, S.W. 1.

* * * *

Electrical Supplies in Cuba.

Owing to the war the sugar industry, which is one of the most important industries in Cuba, has undergone considerable development during the past four or five years, with the result that there is a good demand for all kinds of structural steel work and also for electrical plant and machinery. According to " The Times " Trade Supplement, there is a very promising field for electrical engineers in Cuba. There is an increasing tendency to adopt electric power in sugar mills, and there is a good market for generating sets, electric motors and fittings. It is stated that while American millowners in the island prefer American plant, the Cubans desire an open market. Recently electrical machinery has been imported from the United States, but British plant would be preferred. The adoption of modern methods has led to the need for electric elevators, and many of these are in use, particularly in Havana. There is a pronounced preference for buildings furnished with elevators. All new mills will be equipped with them. At present the United States holds a commanding position in the supply of electrical appliances, but before the war Germany was an enterprising competitor, and it may be again. There are more than 120 electric supply plants in the island, and the generating station of the Havana Electric Railway, Light & Power Company has three turbo-generators of 12,500 kw. each as the main generating equipment. The average central station in the island possesses one or more oil engines, usually of the Diesel type, with belt drive to a d.c. generator or to an alternator. Electricity is generated by independent plants at many sugar mills for their own consumption; but with these exceptions the output of the various stations is used for lighting purposes. Except in Havana, where the street lighting is partly gas and partly electric, the cities have chiefly adopted electric lighting. The systems employed are not, however, modern, and require to be replaced. Meanwhile, there is an increasing field for supplies of fittings for house lighting, of which British suppliers may avail themselves. Not only private houses, but also clubs and the numerous hotels, install the most costly fittings, for which the demand is practically inexhaustible.

Electricity Supply.

Mr. L. F. Walton has been appointed chief constructional engineering assistant at the Southend-on-Sea electricity works at £100 a year.

A new 100 h.p. generating set is to be installed by Lossiemouth Council in order to meet the increasing demand for electrical energy.

Manchester City Council is apparently disposed to extend the scope of its activities, for it has ordered an inquiry into the advisability of the Corporation becoming owner of its sources of coal supply.

Whitby Urban Council has applied for sanction to a loan of £30,000 for extensions of the electric generating plant.

It is announced that the undertaking of the Trafford Power & Light Supply (1902), Ltd., has been acquired by the Stretford Urban District Council, and the transfer has already been completed.

Glasgow Electricity Committee has received the resignation of the chief electrical engineer in consequence of the appointment of Mr. W. W. Lackie as one of the Electricity Commissioners, and a sub-committee has been asked to report on the steps to be taken to fill the vacancy.

For the position of city electrical engineer at Cardiff the following gentlemen have been selected for interview by the Electric Lighting and Tramways Committee: Messrs. Herbert Bell, city electrical engineer, Hull; Sydney Ernest Britton, city electrical engineer, Chester; and C. G. Morley New, deputy electrical engineer, Cardiff.

An interim report on the electric supply undertaking has been prepared for Ayr Corporation by Mr. J. H. Rider. The question of extensions of plant will be dealt with in another report, which will also consider the offer of Kilmarnock Corporation to give a bulk supply, an alternative proposal to erect a new power station for Ayr, and a suggestion to extend the area of supply to Maybole.

According to Mr. Burns, chairman of the Rural Council, the lighting of Hemsworth must be very bad, for he is reported to have said: " As far as I am concerned, I would sooner be without the public lighting than with it. You have to strike a match to see if the street lamps are lit." We are not, therefore, surprised at the further announcement that it was decided to write to the gas company, and also to ask the Yorkshire Electric Power Company for their terms for a supply of electricity.

An inquiry has been held at Derby into the Council's application for sanction to borrow £3,803 for the purchase of property for offices, showrooms and workshops for the electric supply department and £2,500 for the erection of a motor garage. The site for the offices and showrooms was purchased in July, 1918, out of the reserve fund of the electricity department, and the motor garage site was bought for £650. It is now proposed to erect and equip buildings, adjacent to the electricity works, that will house electric lorries belonging to the Corporation.

The seriousness of the position arising from the fact that manufacturers are not able to obtain full supplies of electric power was the subject of a conference between Warrington Corporation Electricity Committee and the leading manufacturers of the district on Thursday. The result of the conference was that a resolution was unanimously passed by the manufacturers pointing out the difficulty in which they found themselves owing to the shortage of supply of electric power and urging that it was essential for the Corporation to develop the policy of central control, or otherwise the manufacturers would have to rely on themselves for their additional requirements in future. Mr. W. Peter Rylands, while mentioning that in the past the Corporation had treated manufacturers in a broad spirit, pointed out that the war had made it impossible for the Council to carry out schemes of expansion, whereas manufacturers were being encouraged to extend to the utmost of their capacity. It was essential that the Corporation should realise that demand would follow the supply, but if it waited for the demand before providing the supply, then manufacturers would be compelled to provide their own.

Dr. Joseph, chairman of the Electricity Committee, said they had been considering what could be done to meet the growing need for further power, and they had consulted an eminent expert whose report they were still considering carefully. Apart from the question of extensions of plant, they were also considering a scheme for a new station.

Proposals for extending the Sunderland electricity works at an estimated cost of £127,000 were submitted to the Council last week by the Electricity Committee. The electrical engineer and general manager (Mr. A. S. Blackman) had reported that he had discussed the scheme with the Chief Electricity Commissioner, who agreed that the extensions were urgently necessary. The load upon the works last December was 8,000 kw., and next December it was estimated that it would be 10,029 kw. No additional generating plant is contemplated, but it is proposed to install at Hylton-road station two additional water-tube boilers, an electric crane and grab for coal handling; an additional cooling tower, and new switchgear. These items will cost £94,781, of which £53,854 is for the two new boilers, £17,615 for the cooling tower, and £19,012 for the new switchgear, with an extra £1,750 for writing off the outstanding back debt on the old switchgear. It is also proposed to install a new 1,000 kw. rotary converter for supplying current for the tramways at £7,725; and to erect a sub-station in the Christ Church area at £22,812.

Mr. Blackman estimates that there will be a reduced coal consumption of 8,500 tons annually, or a saving of £12,325 on the present cost of coal. A sum of £1,446 will be saved by the plant being operated under better conditions, and the works capacity will be increased by 3,000 kw. Several members expressed the opinion that more time should be given for consideration of the scheme, and the chairman of the committee (Councillor Wilson) agreed to take the report back.

Electric Traction.

Ayr Corporation proposes to double the tramway track of four routes and to construct seven passing places on another route at a cost of £44,420.

The question of inaugurating a night service of tramcars for the conveyance of goods and parcels is to be reported upon by the manager of the Liverpool Corporation tramways.

For the position of tramways general manager the following will be interviewed by Cardiff Trnmways Committee: Messrs. James Dobson, general tramways manager and engineer, Southampton; Thomas P. Easton, deputy general tramways manager, Newcastle-on-Tyne; and Robert L. Horsfield, tramways general manager, Walsall.

Negotiations are proceeding between Llandudno Urban Council and the directors of the Great Orme Tramway Company for the purchase by the Council of the cable tramway to the summit of the Great Orme's Head. The Council has instructed the electrical engineer (Mr. H. Morton) to present a further report on the electrification of the tramway, and the company has been asked to fix the firm price at which it will sell the undertaking.

In the estimates prepared in connection with the London County Council's Tramways and Street Improvements Bill, the total expenditure is put at £5,118,500, of which £3,363,500 is estimated to be required for the construction and equipment of the proposed new tramways and the reconstruction of the Embankment tramways, £1,355,000 is for a new street and street widenings, and £400,000 is required to provide omnibuses from or to any point within the county, or beyond the county, but within the Metropolitan Police District.

An accident occurred to an L.C.C. tramcar on Monday when it was ascending Cedars-road, Clapham. The car ran backwards, and, the driver being unable to check its speed, some passengers jumped off, and one succumbed to her injuries.

The report of the inspector who inquired into the accident which occurred on Nov. 28 last on the Burnley Corporation tramways has been issued. A car which was ascending Briercliffe New-road, on the Harlesyke route, ran back for about 180 yds. and overturned on the curve at the bottom, resulting in injuries to four passengers.

The Corporation officials, who examined the overturned car after the accident, found the main controller handle on the first brake notch, and the reversing handle in the forward position. The driver moved the main controller barrel immediately after the accident in order to replace the handle, which had fallen off. Both canopy cut-out switches, which are automatic, were found open. All the cable connections between the controllers and motors were torn out, owing to the parting of the body from the trucks. At the inquiry the controller was in order, except for a loss of temper in the spring of the first brake notch finger, which broke off during examination. All the cables had been torn out of their lugs, with the exception of the positive brush lead of No. 2 motor. This was broken off about a foot from the motor case. There were unmistakable signs of fusing at this fracture, which therefore almost certainly took place when the lead was carrying current. Both motor circuits were tested for continuity and found correct. As there was no sign of fusing at any of the other severed connections, there were strong grounds for assuming that the fracture of the lead took place on some occasion prior to the overturn, and that when the overturn occurred no current was flowing. The inspector's opinion is that "the cable in question parted during the ascent of the hill. Some of the strands were broken already, and the heavy current required for the ascent probably fused the remainder, causing immediate disconnection of No. 2 motor, and, possibly, a momentary overload on the other motor, which may have caused the driving wheels, to which it is geared, to slip. It is more probable either that the broken end of the cable earthed to the car truck, or that a surge of pressure resulted from the fracture; in either case, one or both of the automatic cut-outs probably opened in consequence." Both the driver and the conductor must take some responsibility for the accident. In spite of the failure of No. 2 motor, the driver was at first in no worse position than he would have been had the main supply failed, a contingency for which drivers should always be prepared. Had he used his hand brake properly, he should have had no difficulty in holding the car, and so preventing a run back. Even after that had started he had ample braking power to enable him to keep the car under control. The conductor was not on the rear platform when the run back started, but he should have been according to the Corporation's instructions. He also failed to grasp the situation in time to give the driver adequate assistance. The case is a further example of the serious results likely to follow a run back down a gradient of the kind in question, and the report contains some instructions as to how to minimise the danger.

Imperial and Foreign Notes.

Particulars have reached this country concerning the wreck of the 5,000-kw. Curtis Steam Turbine in the municipal power station at Regina, Canada. According to our contemporary, "Engineering," the machine, which was put into service last autumn, had a normal speed of 3,600 revs. per min., and was direct-coupled to a three-phase, 60-cycle alternator. The turbine was of the five-stage type, the first stage being velocity compounded and the rest being single-impulse stages. The mean diameter of the wheels measured at the centre of the blades were 36 in., 50 in., 50·5 in., 51 in. and 52 in., respectively, the mean blade speeds thus ranging from 565 ft. to 816 ft. per second. The turbine was guaranteed to have a full load consumption not exceeding 13·68 lb. of steam per kilowatt-hour, when operating with steam at 200 lb. gauge pressure superheated 100°F. and exhausting against an absolute condenser pressure equal to 2 in. of mercury. It is believed that the disaster was caused by the bursting of one of the turbine wheels, but the entire machine was utterly destroyed and the true cause may never be ascertained. The machine burst at 7 a.m. on Jan. 8, and could only have been carrying a light load at the time. The winter peak of the station is only about 4,000 kw., and it is therefore probable the machine was not called on to work at its rated capacity. The General Electric Company of America are stated to have dismantled and rebuilt this particular machine before delivery in order to eliminate any possible source of weakness, unfortunately the precaution proved in vain.

A report by M. J. Oferholm on the Electrification of the Swedish State Railways is published in a recent issue of "Elektrische Kraftbetriebe und Bahnen." Figures are given of the estimated cost of proposed extensions, and it is stated that, as regards energy consumption, the output of the Trollhattan Falls station in 1917 would more than cover requirements if the whole of the railways were to be electrified. The electrification is now more than ever advantageous in Sweden, owing to the increased cost of coal. Difficulties caused by climatic conditions are stated to have been successfully overcome.

Business Items, &c.

The address of the Department of Scientific and Industrial Research is now 16-18, Old Queen-street, Westminster, S.W.1. Telephone: Victoria 7,940.

The office and stores of the L.P.S. Electrical Company have been removed to L.P.S. Works, Avenue-road, Acton, London, W.3. Telephone: Chiswick 1,920 (2 lines); telegrams: Engmeyor Act. London.

The manufacturers of the New Electric Adjustable Fitting described and illustrated on page 177 of our issue of the 13th inst. are Messrs. Purit Specialities, Ltd., of 27, Park-street, Birmingham, who will be pleased to send particulars to those interested.

The Electrical & Engineering Development, Ltd., of 82, Victoria-street, London, S.W.1, has been formed for developing and placing on the market electric inventions, for sale of patents, the acquisition of foreign electrical patents, and the development of the export trade. The company, which has appointed prominent engineers as representatives in the principal industrial countries, is equipping an electrical testing department in order to be able to test and develop inventions. The telegraphic address is Utilelec Vic. London; telephone, Victoria 6449.

On the 1st ult., Messrs. the Benjamin Electric, Ltd., of Tariff-road, Tottenham, N. 17, issued a summary of the alterations in their prices and advances, and they now advise that, owing to the heavy advance in materials, &c., they are compelled to make an all-round advance of plus 15 per cent., which will apply to all standard Benjamin lighting specialities covered in section Lists 509 and 511 and will be in addition to the existing advances. For the Benjamin motor and industrial signals (section list No. 512 and leaflet) the prices are advanced by 33⅓ per cent., no previous advance applying.

Metal Industries, Ltd., of Thames-street, Sunbury-on-Thames, state that they are specialising in the supply of plants for building up undersized parts of machinery. The process, which is one of Mr. Cowper-Coles', was largely used during the war. It consists of depositing by a special method an adhesive coating of iron on that part which is to be built up to size. It can then be turned or ground, and if desired, case-hardened. The process will be found of great use in engineering works, and manufactories where there is much running machinery. The company supply complete equipments for a very large variety of work.

Catalogues, Price Lists, &c.

Illustrated particulars and prices are given of "Cressall" electric sterilisers, hot water and boiling jugs and portable water boilers for the medical and dental professions, in a leaflet issued by the Cressall Manufacturing Company, of Birmingham.

Owing to the variety of types, sizes and voltages, the choice of the correct electric lamp for a given purpose is a somewhat complicated business, unless the purchaser has at hand the necessary guiding data. In these circumstances the issue by the British Thomson-Houston Company, Ltd., of a revised edition of their Incandescent Electric Lamp Handbook on Group 1, vacuum and half-watt type Mazda lamps, will be welcomed by all concerned. This handbook (No. 1B), containing 64 pages of letterpress and illustrations, gives complete information on all lamps, both vacuum and half-watt, of 20 volts and above. These comprise vacuum type Mazda lamps for ordinary lighting, and also traction, train lighting, tubular and candle lamps, while in the half-watt section are included both regular and train lighting types; 20 pages are devoted to scale illustrations of lamps and tabulated information. An enumeration of column headings will give an indication of the completeness of the data. These headings are as follows: Volts, Watts, Approximate British C.P., Efficiency W.C.P., Bulb Designation, Diameter and Length in mm. and Inches, Cap regularly supplied, Lumens, Standard Packing, Quantities, Price. Apart from these data, there is a great deal of general information on lamps and lighting. One extremely useful feature is a glossary of terms used in the incandescent lamp industry, including definitions of the classes of buyers. Full instructions are given for ordering lamps, while another section deals exhaustively with the important matter of sales terms and discounts. There is also a section containing full size illustrations of the various types of caps used. In view of the acknowledged shortcomings of the candle-power unit as a measure of light output, the section on the lumen will prove of considerable interest both to the technical and the lay reader. The last section gives brief definitions of the more important terms and units employed in illuminating engineering. Copies of the handbook may be obtained from Mazda House, 77, Upper Thames-street, London, E.C.4.

Institution Notes.

Glasgow R.E. Signal Company.—The Volunteer R.E. Signal Company which was raised in Glasgow in February 1918 was disbanded on the declaration of peace and the balance of funds amounting to £197 0s. 11d., have now been handed over to the Benevolent Fund of the Institution of Electrical Engineers.

Physical Society.—At the recent annual general meeting the following officers and council were elected:—

President: Prof. W. H. Bragg, C.B.E., M.A., F.R.S.; *Vice-Presidents*: Prof. R. B. Clifton, M.A., F.R.S., Prof. A. W. Reinold, C.B., M.A., F.R.S., Sir W. de W. Abney, R.E., K.C.B., D.C.L., F.R.S., Sir Oliver J. Lodge, D.Sc., F.R.S., Sir R. Glazebrook, K.C.B., D.Sc., F.R.S., Prof. J. Perry, D.Sc., F.R.S., C. Chree, Sc.D., LL.D., F.R.S., Prof. H. L. Callendar, M.A., LL.D., F.R.S., Sir A. Schuster, Ph.D., Sc.D., F.R.S., Sir J. J. Thomson, O.M., D.Sc., F.R.S., Prof. C. V. Boys, F.R.S., Prof. C. H. Lees, D.Sc., F.R.S., H. S. Allen, M.A., D.Sc., Prof. W. Eccles, D.Sc., Prof. A. S. Eddington, M.A., M.Sc., F.R.S., R. S. Willows, M.A., D.Sc. *Secretaries*: D. Owen, B.A., D.Sc., F. E. Smith, O.B.E., F.R.S. *Foreign Secretary*: Sir Arthur Schuster, Ph.D., Sc.D., F.R.S. *Treasurer*: W. R. Cooper, M.A., B.Sc. *Librarian*: A. O. Rankine, D.Sc. *Other Members of Council*: C. R. Darling, F.I.C., Prof. C. L. Fortescue, O.B.E. E. Griffiths, D.Sc., E. H. Rayner, M.A., D.Sc., A. Russell, M.A., D.Sc., Prof. Sir Ernest Rutherford, D.Sc., F.R.S., G. F. C. Searle, M.A., D.Sc., F.R.S., T. Smith, B.A., J. H. Vincent, D.Sc., M.A., F. J. W. Whipple, M.A.

On the 23rd inst., the members of the Committee (past and present) of the Scottish Local Centre of the I.E.E., entertained to dinner Mr. W. W. Lackie and Mr. A. Page, on the occasion of their leaving Glasgow to act as Electricity Commissioners. Mr. W. B. Hird, chairman of the Scottish Local Centre, presided, and proposed the health of the guests, both of whom replied at some length. Dr. Magnus Maclean proposed Mr. Goslin's health, and referred to that gentleman's appointment as general manager of the Clyde Valley Electrical Power Company.

British Engineering Standards Association.—British Standard Specifications. The following new and revised publications have recently been issued by this Association: No. 73, 1919, "British Standard Specification for Two-pin Wall Plugs and Sockets"; No. 79, 1919, "Report on British Standard Special Trackwork for Tramways"; No. 98, 1919, "British Standard Specification for Goliath Lamp Caps and Lamp Holders." The price of each report is 1s. 2d., and copies may be obtained from the offices of the Association, 28, Victoria-street, S.W.1.

At the request of the Machine Tool Trades' Association, a conference under the aegis of the British Engineering Standards' Association, has been arranged to discuss the question of the standardisation of gears. Primarily, its purpose is to give the industry an opportunity of discussing the problems which beset the subject with a view of deciding whether standardisation would be practicable, and, if so, to what extent it could be carried out. It is understood that American manufacturers are devoting considerable attention to this question, and, as the British Engineering Standards Association is in close communication with the American industry through the American Engineering Standards' Committee, the proposed conference should do much to bring British manufacturers together at an opportune time, as well as promote Anglo-American co-operation on a most important subject.

The conference is to be held under the direction of the Sectional Committee on Machine Parts, their Gauging and Nomenclature, on March 5, at 2.30 p.m., at the Institution of Civil Engineers, Great George-street, S.W.1. A number of invitations have already been issued, but any individual, firm or expert who has not received a communication, and who is directly interested in the question, is invited to communicate with the Secretary of the British Engineering Standards' Association, 28, Victoria-street, S.W.1.

The annual dinner of the N.E. Division of the Electrical Power Engineers' Association was held on the 17th inst. at Newcastle-on-Tyne, under the presidency of Mr. A. S. Blackman, M.I.E.E., M.I.M.E., and the large company gathered indicated the activity by and support of the E.P.E.A. on the north-east coast. Mr. A. L. Lunn, past president of the E.P.E.A., who proposed the toast of "The Guests," said he was pleased to note the presence of so many chief engineers. The Association was not looked upon with favour when it commenced its activities, but events had proved that it was started at the right time. He had recently read in the "Journal" of the Electrical Trades Union that "there was only one fly in the ointment, and that was the E.P.E.A.," and they were going to dig it out. He could assure the gentlemen concerned that they would not dig that fly out of the ointment, as the E.P.E.A. was here to stay. Mr. R. P. Sloan, C.B.E., M.I.E.E., responded, and said the increase of 40 per cent. in the membership of the Association during the past year was a healthy and satisfactory feature. The E.P.E.A. had been a benefit to the electricity supply industry, as it had compelled the employers to come together. The objects of the E.P.E.A. were laudable, and they had his sympathy and support.

Mr. E. Moxon proposed the toast of "The E.P.E.A.," and in response Mr. C. Vernier, M.I.E.E., indicated the work of the Association in connection with the Electricity Supply Act, and the issue of award 9281. In his opinion, the most important work that the Association had accomplished was the formation of the National Joint Board of Employers and Staff Members for the Electricity Supply Industry. The board was engaged at present in the consideration of the minimum salaries of the technical staffs of the undertakings.

Miscellaneous.

The employees of Pope's Electric Lamp Company, Ltd., held their second concert on the 17th inst., which was even more successful than their first, held a month ago.

The annual examinations for a Faraday scholarship of 50 guineas per annum tenable for two years in Faraday House Electrical Engineering College and one year in manufacturing works, and for a Maxwell scholarship of 50 guineas per annum tenable for one year in College and one year in works, will be held on April 13, 14 and 15. Particulars from the Secretary, Faraday House, Southampton-row, London, W.C.1.

A dinner and smoking concert to ex-service members of the Blackpool Corporation Electricity and Tramways Institute, who were members prior to joining H.M. Forces, was held on Friday. Mr. C. Furness, the tramways manager and electrical engineer, who is president of the Institute, presided over an attendance of 150, and he was supported by the Mayor and Councillor H. Brooks, chairman of the Committee.

The Board of Trade have appointed a Committee, under the chairmanship of Sir Thomas Bell, K.B.E., to advise what conditions should be complied with in order to prevent danger of fire, including fire resulting from collision, in the case of passenger ships burning oil fuel, and what special precautions (if any) are necessary in the case of oil fuel with a flash point as low as 150 F. The secretary to the committee is Mr. G. C. Ager, and communications should be addressed to him at the Board of Trade, Great George-street, Westminster, S.W.1.

The Postmaster-General has decided to equip a New Telephone Exchange on the common battery system at Dundee. In making this announcement the Postmaster-General states that "Although automatic equipment has been found to work with a high degree of efficiency, the economic advantages usually urged in its favour have not always been attained in practice, especially where considerable use is made of trunk and junction circuits, as it is found necessary to retain a large force of telephonists. Apart from this, the tenders which have recently been received for the provision of automatic exchanges are so high as to be practically prohibitive."

The Ideal Home Exhibition was fittingly brought to a conclusion, so far as electrical engineers were concerned, by a Press visit to the all-electric house arranged by the General Electric Company. At a luncheon preceding the visit, Mr. Hirst made, as is usual, an interesting and suggestive speech. He remarked that extremely cheap electricity was a necessity, and that the sooner the all-electric home became the fashion the better for everybody. The Exhibition, he said, had greatly disappointed him, owing to the small part which electricity played in it. Six years of war had caused electric heating and cooking to be forgotten, and the industry was now beginning again where it left off in 1914. In spite of the present level of prices, the public would undoubtedly buy large quantities of electrical apparatus; but the real electric home would only come when the price of electricity fell to one-tenth or one-twelfth of a penny per unit.

At the Midland Hotel, Manchester, on Friday last, Mr. A. W. Tait, chairman of Ferranti Limited, presided at the Eighth Annual Staff Dinner, nearly 200 (staff and guests) being present. The function, which was followed by a dance, again evidenced the genial relations existing between the directors and staff. Dr. Ferranti and Mrs. Ferranti were present, and the guests included Mr. J. A. Robertson (borough electrical engineer, Salford), Mr. H. C. Lamb (deputy city electrical engineer, Manchester), Mr. W. J. H. Wood (borough electrical engineer, Bolton), Mr. A. P. Wood (Lancashire Dynamo & Motor Company), and Mr. B. Longbottom (Electromotors Limited). The brief toast list was interspersed with musical items by Mr. A. Ellis, Mr. W. E. Crawley, Mr. G. Barker and a few stories by Mr. W. E. Warrilow. Mr. J. A. L. Campion rendered with his usual vigour "My Old Shako" (now known as the Ferranti anthem), and everyone had to join in the chorus on penalty of not being invited next year. The dance was a huge success.

Personal and Appointments.

Our readers will be glad to learn that Mr. F. H. Rudd, borough electrical engineer of Rochdale, who has been away on a two months' holiday owing to ill-health, has returned to duty considerably better.

Mr. R. Hoggard, chief traffic assistant in Sheffield Corporation tramways department, has been appointed traffic superintendent of Wigan Corporation Tramways at £275 per year.

Major Cecil Turner, R.A.F., Editor of our contemporary "Aeronautics," has arrived at Aswan, 425 miles from Cairo, in the Handley-Page machine which is taking part in the "Daily Telegraph" flight from Cairo to the Cape. Major Turner's account of the flight is now appearing in the "Daily Telegraph," and will be followed with interest by all those concerned with the progress of aeronautics.

Mr. Percy Priestley, deputy manager of the Liverpool Corporation tramways for the past two years, has been selected by the Tramways Committee for the position of general manager, in succession to Mr. C. W. Mallins, who is retiring. Mr. Priestley, who is about 45 years of age, was born in Sunderland, and served his apprenticeship as an engineer with Sir Wm. Allan, Ltd. In 1901 he was appointed assistant engineer at Halifax Corporation electricity works, and 10 months later became borough electrical engineer, in which position he remained until 1907, when he was selected as general manager to the Mexborough and Swinton Tramways Company. While at Mexborough the Dolter surface contact system was discarded for the overhead method. In March, 1916, Mr. Priestley became general manager and engineer to the Oldham Corporation tramways, and two years ago went to Liverpool as deputy tramways manager.

Tenders Invited and Accepted.

Dunedin (N.Z.) Council require tenders by April 26 for electric car bodies, car trucks and equipment. Specifications from the Town Clerk.

Tenders are required by March 15 for the supply of electrical goods, &c., to the Cheshire County Asylum, Parkside, near Macclesfield. Forms of tender from the Clerk.

Doncaster Corporation invite tenders for two 3,000 kw. 3-phase turbo-generators with condensing plant. Specifications from the electrical engineer (Mr. S. R. Windle) and tenders to Town Clerk, by March 2.

Aylesbury Corporation require tenders by noon March 10 for the supply and fixing of two electric motors and pumps at the sewage works. Specifications can be seen at the office of the Borough Engineer.

Barrow-in-Furnace Corporation require tenders by noon March 8 for the supply of electrical stores, meters, joint boxes, &c. Forms of tender from the Borough Electrical Engineer.

Clydebank Corporation require tenders by March 13 for electric wiring and fitting work in 160 houses to be erected at Kilbowie. Forms of tender, &c., from the Burgh Surveyor, Clydebank.

The Victorian Government Railways Department require tenders by March 31 for galvanised telegraph wire Nos. 8 and 12 (contract 32,895). Specification from the Railway Commissioners, Melbourne.

The N.Z. Government Public Works Department require tenders by March 31 for supply of 1 mile of 11,000 volt underground cable at Lyttleton. Specifications from the department at Auckland, Dunedin, Christchurch or Wellington.

Dundee Tramways Committee require tenders by March 4 for year's supply of armature coils, carbon brushes, insulating tapes, overhead equipment material, steel tyres, centres and axles, &c. Forms of tender from the General Manager.

The City of Melbourne invites tenders for the supply of 12,000 metal filament lamps. Specifications from the agents of the City Council, Messrs. McIlwraith, McEacharn & Company Ppty., Ltd., Billiter-square-buildings, London, E.C. 3, to whom tenders by noon March 30.

Oudtshoorn (Cape Province) Municipality require tenders by March 24 for supply of a loco. type steam set with generator and switchboard, or, alternatively, (*a*) boiler and auxiliaries, (*b*) steam set with generator, (*c*) condenser and auxiliaries, and (*d*) switchboard. Specification from the Municipal Electrical Engineer.

Halifax Electricity and Tramways Committee invite tenders for supply and erection of a 10,000 kw. turbo-alternator with condenser. Specifications from the borough electrical engineer (Mr. W. M. Rogerson), and tenders by noon March 12 to the Town Clerk (Mr. Percy Saunders), Town Hall, Halifax.

Aberdare Urban Council invite tenders for one year's supply of stores for the electricity and tramways departments, including cables, meters, joint boxes, electric lamps, ironmongery, &c. Forms from the general manager, and tenders to the clerk (Mr. W. R. Morgan), by March 8.

Gellygaer Urban Council invite tenders for the supply of transformer plant and h.t. and l.t. switchgear for substations, also a quantity of 11,000 volt and 500 volt overhead line material. Specifications from the resident engineer and manager, Bank Chambers, Bargoed, and tenders to the clerk, Mr. Frank T. James, by March 24.

Hammersmith (London) Borough Council invite tenders for the supply of electricity stores, including electric light sundries, fire bricks, insulated wire, cable ducts, joint boxes, meters, cable compound, engineering tools, steam packing, &c. Forms from the borough electrical engineer, Mr. G. G. Bell, and tenders to the Town Clerk (Mr. Leslie Gordon), Town Hall, Hammersmith, W.6, by 4 p.m., March 3.

The Great Central Railway Company invite tenders for 12 months' supply of various stores and materials, including electric line construction material and apparatus, wires and cables, casing, accessories and lamps, &c. Specifications from Mr. Walter Williams, stores superintendent, Gorton, Manchester, and tenders to the secretary, Mr. J. A. Campbell, Marylebone Station, London, N.W., by March 17.

Lincoln Corporation invite tenders for the supply and erection of an accumulator battery at St. Swithin's power station. Specifications from Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, Westminster, S.W.1; and specifications can also be seen at the office of the city electrical engineer, Mr. Stanley Clegg. Tenders, on forms to be obtained from the Town Clerk's office by March 2.

Belfast Electricity Committee invite tenders for various stores and materials, including mill furnishings, packing and asbestos goods, lubricating oils, tools, cables, wires, electrical accessories, lamps, carbons, troughing, conduits, c.-i. and w.-i. pipes, feeder and suction pillars, meters, &c. Forms of tender from the City electrical engineer, Mr. T. W. Bloxam, and tenders must be lodged at the office of the Town Clerk (Mr. R. Meyer), City Hall, Belfast, by March 10.

For the supply of a turbo-alternator, Hull Electricity Committee received 10 tenders, varying in amount from £42,965 to £51,619, and 11 tenders for condensing plant varying from £15,722 to £19,833.

King's Lynn Council has accepted the tender of Davidson & Company for induced draught fan, £857; and that of Belliss & Morcom for air and circulating pumps, pipe work and feed water purifier at £2,886.

Salford Corporation recently accepted the following tenders: B. Thomas, additional switchgear at the Trafford sub-station: Metropolitan Vickers Electrical Company, 5,000 kw. turbo-alternator set, 1,500 kw. rotary converter set, spare rotor and switchgear for premises of J. & J. M. Worrall; Chloride Electrical Storage Company, testing battery.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

116.104 Soc. Gallot et Cie & Soc. Pelissin, Rondeaux et Cie. Apparatus for the electrical separation of substances in suspension in gaseous media. (22/5/17.)

Comprises a tubular electrode which may or may not be perforated, in the longitudinal axis of which a wire, constituting the second electrode, is stretched and supported by means of insulators mounted in attached chambers. The apparatus is characterised by the arrangement of the inlet for the gases that are to be freed from dust, which is constructed in such a way that between the inlet for the gas that is to be freed from dust and the chamber of the insulator to be protected an electrical protecting zone is created, consisting either of a portion of the tubular electrode or of a perforated or unperforated auxiliary tubular electrode of reduced length.

135.816 Elektro-Osmose Akt.-Ges. (Graf Schwerin Ges.) Electrodes for electro-osmotic processes. (20/10/17.)
137.089 Harman & Le Bas. Dynamo-electric machines. (21/12/18.)
137.090 Ferranti, De Wall & Ferranti Limited. Measurement of alternating-current power. (21/12/18. Cognate application, 15.447/19.)
137.098 Turner & Wagner. Wireless telephone transmitters. (24/12/18.)
137,101 Walter. Generation of electricity by thermo-electric batteries. (30/12/18.)
136,282 Joel. Electric accumulators. (16/12/18.)
136.287 King. Visual electrical indicators for collieries and other mines. (18/12/18.)
136.303 Harman & Le Bas. Commutators for dynamo-electric machines. (21/12/18.)
136,600 Murray Erskine & Robinson. Apparatus for determining the direction of arriving electro-magnetic waves. (9/12/18.)

A closed loop, or coil, forming a directive electromagnetic reception device, connected to any suitable form of detector or reception device and actually or virtually displaceable about a pivot, is arranged not only to be capable of free movement about said pivot, but also through a small fixed angle, predetermined by stops preferably adjustable, which stops are contacts in the form of the reception device.

136.601 Codd. Induction coils. (2/6/19.)
136.605 Cable Accessories Co., Reeves & Crawford. Electrical fuses. (12/12/18.)
136.627 Pollak. (Fabbrica Isolatori Livorno.) Electric insulators. (17/12/18.)
136.650 Joyce & Park Royal Engineering Works. Electric switches. (19/12/18.) (Cognate Application, 13.453/19.)
136.654 Barber. Transmission and reception arrangements for electro-magnetic signalling. (20/12/18.)
136.865 Bernard. Electric heaters for liquids and the like. (20/11/18.)
136.872 Harrison. Dynamo-electric machines. (23/12/18.)
136.900 Lauth. Electric cooking or heating vessels and apparatus. (30/12/18.)
136.913 Dennis & Law. Automatic electric water-heaters. (30/12/18.)
136.918 Abegg. Electric switches. (31/12/18.)

1919 Specifications.

122,185 Dayton Engineering Laboratories Co. Interrupters for use in electric ignition systems. (2/1/18.)
125,077 Naamlooze Vennootschap Fabriek van Instrumenten en Electrische Apparaten "Inventum." Two, three or multiple pin plugs. (4/4/18.)
131,587 Duvauchelle. Internal combustion engines. (19/8/18.)
136,162 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij. Thermic telephone systems. (4/12/18.)
137,133 Fawdry & Dawson. Suspending conductor wires on electric railways and the like. (27/1/19.)
137,144 Grime & Mather & Platt. Starting and synchronising of synchronous dynamo-electric machines. (8/2/19.)
137,147 British L. M. Ericsson Mfg. Co., Blades & Sutherland. Electro-magnetic relays. (13/2/19.)
137,150 Walker. Electro-magnetic step-by-step signalling and synchronous rotation. (14/2/19.)
137,155 Collie. Method of locking electric lamps in their holders for use with Majolica fittings and the like. (19/2/19.)
137,199 Weatherall. Winding of induction coils. (7/4/19.)
137,223 Lishman. Electrical measuring instruments. (16/5/19.)
137,237 Walsh & Kingsland. Secret contact combination electric switches. (16/6/19.)
137,240 Lauth. Electric cooking or heating vessels and apparatus. (23/12/18. Divided application on 21.547/18.)
137,241 Lauth. Electric cooking or heating vessels. (23/12/18. Divided application on 21,547/18.)
137,249 Fitzgerald. Electric laundry irons. (21/7/19.)
137,255 Walker. Electro-magnetic step-by-step and like mechanism. (14/2/19. Divided application on 3,692/19.)
137,261 Perot. Remote control electric switch. (21/8/19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

October 22.

25,838 Taylor. Electrical distribution in a.c. systems.
25,841 Edwards & Staik. Electric motor controllers.
25,842 Berresford. Tram rails.
25,899 Morgan & Seabrook. Magnetos.
25,910 Metropolitan-Vickers Electrical Co. & Hassler. Brush holders for dynamos)
25,918 Bruce. Electric and gas fires.
25,924 and 25,930 Ferranti & Wall. Measurement of a.c. current power.
25,926 Carey. A.c. induction motors.
25,948 Schattner. Excess current indicators.
25,953 Wade. (Mills.) Alternating current rectifiers.

October 23.

25,999 Lee. Supporting electrical conduits and cables.
26,013 Siemens & Co., Ges. Electric light carbons. (5/8/16. Germany.)
26,014 Siemens & Co., Akt. Ges. Electric compasses for ships. (11/7/18. Germany.
26,016 Frecheville. Electrically operated horns for motor vehicles.
26,036 B.T.H. Co. & Young. (G.E. Co.) Magneto-electric machines.
26,040 Gush. Electrical apparatus for prevention of corrosion in steam condensers, &c.
26,046 Lenaghan. Telephone systems.
26,047 Lenaghan. Automatic telephone systems.
26,057 Aspden & Bowman. Electrical equipment of motor vehicles.

October 24.

26,065 Taylor. Electrical distributon in alternating current systems
26,118 Soc. Anon. pour l'Exploitation des Procedes Westinghouse-Leblanc. Installing rotors of high tangential and angular velocity. (7/11/18. France.)
26,126 Igranic Electric Co. & Mackley. Gate switches and blocks.
26,132 Best. Pendants for lighting.
26,154 Metropolitan-Vickers Electrical Co. Radiating or cooling apparatus.
26,165 B.T.H. Co. (G.E. Co.) Controllers for electric motors.
26,166 Alexanderson. Cooling dynamo electric machines. (26/11/18. U.S.)
26,167 B.T.H. Co. (G.E. Co.) Automatic arc welding.

October 25.

26,199 King. Electric torches.
26,223 Joseph. Electrically heated cooking utensils.

Companies' Reports, &c.

The directors of the Telegraph Construction & Maintenance Company, Ltd., propose to pay a further dividend of 7½ per cent.

The directors of the Halifax & Bermudas Cable Company, Ltd., have declared an interim dividend at rate of 6 per cent. per annum, tax free, on the ordinary shares for the past half-year.

Sir Henry E. F. Goold-Adams, who was chairman of The Munitions Invention and Nitrogen Products Committee, has joined the board of Low Temperature Carbonisation, Ltd.

The Direct West India Cable Company, Ltd., has declared an interim dividend at rate of 6 per cent. per annum, tax free, on the ordinary shares for the past half-year.

The directors of the Bournemouth & Poole Electricity Supply Company, Ltd., recommend a final dividend on the ordinary shares at the rate of 7 per cent. per annum (less tax) for the past half-year, making 6 per cent. for the year.

The directors of the Newcastle-on-Tyne Electric Supply Company, Ltd., recommend a dividend of 8 per cent. on the ordinary shares for the past year, of which 2½ per cent. was paid in September last.

The directors of the Fife Tramway, Light & Power Company, Ltd., recommends payment of a dividend of 8 per cent. (less tax) for 1919, against 7 per cent. in 1918. A sum of £10,000 has been placed to reserve and £4,619 carried forward.

The directors of the Lancashire United Tramways, Ltd., recommend payment of the full interest of 5 per cent. on the second mortgage debenture stock for the past year and £7,220 is to be placed to depreciation account.

The directors of the Kensington & Knightsbridge Electric Lighting Company, Ltd., recommend a dividend of 4½ per cent. on the ordinary shares for the half-year ended Dec. 31, 1919, making, with the interim dividend paid in August last, 7 per cent. for the year.

The subscription list in connection with the recent offer of 200,000 7 per cent. cumulative participating preference shares and 200,000 ordinary shares of £1 each in S. Smith & Sons (Motor Accessories), Ltd., has been closed as the issue was over-subscribed.

The directors of the Charing Cross, West End & City Electricity Supply Company, Ltd., have decided to recommend a dividend on the ordinary share capital of the West End undertakings for the half-year ended Dec. 31, 1919, at the rate of 5s. per share, making, with the interim dividend already distributed, 7 per cent. for the year 1919.

The directors of the South London Electric Supply Corporation recommend a final dividend at rate of 8 per cent. per annum for the half-year on the ordinary shares, making 6 per cent. for 1919, an increase of 1 per cent. over 1918. £1,000 has been placed to depreciation and £2,500 to general reserve, leaving about 11,238 to be carried forward, against £3,717.

The directors of the Chelsea Electricity Supply Company, Ltd., announce a dividend at rate of 5 per cent. per annum on the ordinary shares for the half-year, making 4 per cent. for 1919. A sum of £16,688 is placed to depreciation account, £1,089 written off cost of extinction of founders' shares, leaving about £1,500 to be carried forward.

At an extraordinary general meeting of Stewarts & Lloyds, Ltd., last week a number of resolutions were adopted, involving the issue of the balance of the authorised deferred shares, the creation of additional deferred shares and the alteration of certain rights held by the preference shareholders in the event of a liquidation. The directors have under consideration the putting down of steel works in England.

The directors report submitted at the meeting of the Mersey Railway Company yesterday (Thursday) stated that the total amount available for payment of interest was £48,113. The interest on the new first perpetual debenture stock absorbed £26,776. Four per cent. was paid on the 1866, 3 per cent. on the 1871 and the 1882-3-5, and 1 per cent. on the "B" debenture stock, leaving £60 to be carried forward.

The directors of the County of London Electric Supply Company, Ltd., recommend a final dividend at the rate of 11 per cent. per annum on the ordinary shares, making 8 per cent. for the year 1919, an increase of 1 per cent. over 1918. The sum of £50,000 has been placed to depreciation, and a general reserve fund has been created by placing £45,000 to same, leaving £19,000 to be carried forward, against £15,515.

The profit of the Tramways, Light & Power Company, Ltd., for 1919 was £43,947, making, with £5,806 brought forward, a total of £49,753. After providing for loan and debenture interest, debenture redemption and the preference dividend to July 1919, the available balance was £24,281. It is proposed to pay a dividend on the ordinary shares at rate of 7 per cent. per annum, to transfer to reserve fund £10,000, and carry forward £3,833.

The annual meeting of the Smithfield Markets Electric Supply Company, Ltd., took place yesterday, when it was reported that the gross profit for 1919 was £6,588, against £470, and the net profit £5,464, compared with a loss of £1,749 in 1918. A sum of £2,000 has been placed to depreciation fund and £400 to debenture stock redemption fund. After deducting debit balance at end of 1918, there remained £2,529, out of which a dividend at rate of 2 per cent. per annum was declared on the ordinary shares and £1,329 carried forward.

The net profit of Messrs. Mather & Platt, Ltd., for 1919, after charging depreciation, &c., was £182,417, from which the directors have transferred to income-tax equalisation account £31,500. With balance brought forward, less £120,000 transferred to reserve account, the available total is £151,745. The directors recommend a dividend for the past half-year on the ordinary shares of 5 per cent., together with the amount of income tax deducted from the interim dividend, making 10 per cent. for the year, and a dividend for 1919 on the 150,000 new ordinary shares of 10 per cent., carrying forward £26,745.

The directors of the City of London Electric Lighting Company, Ltd., have decided, subject to audit, to recommend payment of the following dividends, &c.: On the preference shares, 12s. per share, being at full rate of 6 per cent. per annum; and on the ordinary shares 20s. per share, being at rate of 10 per cent. per annum. On account of these dividends, 6s. per share was paid in September, and the balance remains to be paid. In addition, the directors have decided to recommend payment of a bonus of 6s. per ordinary share, being the equivalent of 3 per cent. on account of reductions of dividends during the war, thus restoring the rate of dividend paid for 1914 and 1915 to the pre-war rate of 10 per cent., leaving the reductions in 1916, 1917 and 1918 to be dealt with in future. After payment of the dividends and bonus (less tax), and providing for other appropriations, there will remain about £23,000 to be carried forward.

Inclusive of £2.0 brought forward from last year the net profit of the Oxford Electric Company, Ltd., was £10,065. After providing for debenture and sundry interest, the balance available is £7,938, and the directors propose to pay a dividend at rate of 5 per cent. per annum on the preference share capital (whereof 2½ per cent. was paid in Sept. last), and a dividend for the year at the rate of 5 per cent. (less tax) on the ordinary share capital, leaving £188 to be carried forward. The improvement in local commercial conditions, consequent on the resumption of academic life, has resulted in an increased output during the last quarter of the year, and it is anticipated that with the removal of the restrictions on the use of electricity the improvement will be maintained. The new customers added, and the volume of business obtained during the later periods of the year, have been quite satisfactory.

The Capital expenditure during the war has been met almost entirely out of revenue; but it is no longer possible to continue this policy, and, therefore, an issue of capital will be made in the near future.

The report of the National Electric Supply Company, Ltd., for 1919 states that the expenditure on capital account for the year was £16,934. In order to meet the increasing demand for current for both power and lighting an extension of the generating machinery at the works was put in hand during the year, but owing to labour difficulties, the plant could not be completed for this winter's load. The gross profit is £18,612, which, with balance from last year, makes a total of £18,854. After paying interest on loans, &c., and placing £5,000 to reserve for depreciation, the directors recommend a dividend at rate of 5s. per share on the ordinary shares, which, with the interim dividend, will make 7s. 6d. per share for the year, and a dividend of £1. 7s. 2d. each on the founders' shares, placing to reserve fund £3,000, carrying forward £1,036.

Mr. John Booth, who presided over the meeting on the 19th inst., stated that it was an open secret that a super-power station would be built on the Ribble in the district. They had one of the finest sites in the country for such a station. In a few years they would be able to supply an almost unlimited amount of electric power at a very low rate, which would bring an era of prosperity to Preston.

The revenue account of the South Metropolitan Electric Light and Power Company, Ltd., for the year 1918 shows a credit balance of £70,108 16s. 9d., which, with £12,857 6s. 2d. brought forward, and £1,001 14s., the dividend of 10 per cent. per annum on the company's holding of shares in the West Kent Electric Company for the year 1918, makes a total of £83,967 16s. 11d. After deducting £15,354 15s. 11d. for interest on debenture stock and for other interest, and £7,894 17s. 2d. for interim dividends on the preference shares, there remains £60,718 3s. 10d. The directors now recommend payment of final dividends upon the 7 per cent. cumulative first and 6 per cent. cumulative second preference shares, placing £21,500 to depreciation fund, and £10,000 to reserve account, and a dividend of 6 per cent. on the ordinary shares for the year 1919, leaving £12,323 6s. 8d. to be carried forward. The general business of the company has been well maintained, notwithstanding a large, but the directors hape temporary, reduction in the demand for bulk supply. A dividend of 10 per cent. has again been recommended by the West Kent Electric Company. Mr. Henry W. Bowden, M.Inst.C.E., has resigned his position as director and engineer-in-chief, but he has consented to act as consulting engineer.

The directors of the Automatic Telephone Manufacturing Company, Ltd., have received assents from shareholders for the exchange of the requisite number of shares for shares in the new company to be formed. An arrangement was made with the International Syndicate, who were about to form the new company (the International Automatic Electric Company) for the right to do business in 11 of the principal European countries from which the English company was excluded. The new company's capital is £920,000, and provided the holders of not less than 51 per cent. of the shares of the Automatic Company had agreed to exchange their shares for shares in the new company before the 18th inst. the International Syndicate agreed to deliver to the new company manufacturing orders which they had already arranged to the following minimum amounts:—In 1920, £100,000; in 1921, £150,000; in 1922-27 (inclusive), £200,000 per annum; all of which business is to come from countries outside of the United Kingdom, and is to carry a fixed percentage of profit. The International Syndicate, who are organising the new company, estimate that they will also receive a substantial amount of other business. The International Syndicate are prepared to cause the new company to have the apparatus so ordered manufactured by the Automatic Telephone Manufacturing Company.

London Electric Supply Corporation.

At the annual meeting on the 20th inst., the chairman (Mr. Robert H. Benson) gave a long and interesting account of the origin and history of the company, as well as an outline of the restrictive legislation relating to electricity supply. He paid a warm tribute to the vision and foresight of the founders—Sir Coutts Lindsay and his brother (Lord Wantage)—and to the pioneering work of Dr. Ferranti at Deptford station, which was 10 years before its time. England was then leading in electricity supply, but it lost its lead because Parliament, in terror of monopoly, allowed many small competing companies to start, instead of centralising production on a large scale at the point where coal was cheapest and condensing water was plentiful. Parliament could have cured its mistake by simply putting pressure on its own creatures, the 13 companies and the local authorities, to amalgamate upon a fair relative valuation.

It was a mistake to imagine that the London district had been starved for lack of cheap and plentiful power. In 1914 the figure of ½d. per unit (total cost) had already been reached by their own company, which was selling current for traction and industrial purposes at prices varying from 0·45d. to 0·60d.; and, if the war had not occurred, prices would no doubt have been reduced still further. It was no fault of existing companies that the cost of coal and wages and taxes in 1919 had doubled the cost of generation compared with 1914. Even in Chicago, with a total output of 700,000,000 units in 1913, against a much smaller amount in London, those costs were not bettered. "Would it not be madness if Parliament, at this 11th hour, were to dismiss, or supersede, the best brains of the engineering staffs of the existing companies, who, amongst them, have already managed, in spite of their shackles, to give a supply of power as cheap, or even cheaper, than Chicago, with its far larger output?" In order to enable all the London companies to pool their resources and experience, a little company called "The London Electricity (Joint Committee), 1920, Ltd.," had been registered. At a moment when economy in public finance is imperative, the feeling prevailed that, apart from the improvidence of dismembering existing organisations and scrapping technical and local experience, the Treasury might well be appalled at the prospect of having to find £200,000,000 or more for compulsory purchase of existing plant and development of super-stations up and down the country, especially at the moment when confronted with vast expenditure for housing. In the London district alone the value of existing plant may perhaps be put at £23,000,000, and it is probable that as much again could be well spent in the course of the next 10 years. The financial problem of finding the money in such a way as not to be a burden to the State, but a positive source of revenue and a contribution to the relief of taxation, was not insoluble. Success depended on two main things: (1) Increased output of power and no handicaps; (2) the restoration of the credit of our industry and active support at Westminster instead of harassing conditions. The dividend on the ordinary shares was 4 per cent. in 1914, and last year it was 2½ per cent., less tax. For the four intervening years there was no dividend. Could anybody say that their shareholders got, or had ever got, too large a share of the price of their product?

The report stated that the profit was £95,240, against £78,376 in 1918. With amount brought forward (£10,398) and deducting interest on temporary loan, &c. (£1,287), the total was £104,351. Interest on debenture stock required £23,494, and sinking fund for redemption of debenture stock £16,580, leaving £64,277. The board propose to pay a dividend of 6 per cent. on the preference shares, of which an interim dividend of 3 per cent. was paid in September (£26,952), and a dividend of 2½ per cent. on the ordinary shares (£8,325), to place £12,500 to reserve, £5,000 to contingencies and to carry forward £11,500. The supply has been efficiently maintained during the year. The number of units sold amounted to 42,907,637, against 46,357,227, the total costs per unit sold being 1·17d., against 1d. last year. The average receipt per unit sold (lighting and power) was 1·60d., compared with 1·35d.

Underground Railway Meetings.

The meetings of the group of companies in the Underground Electric Railways Company of London took place last week.

Presiding over the meeting of the City & South London Railway Company, Lord Ashfield said their big scheme of development included the widening of the greater part of the railway, equipping it with modern rolling stock and making a junction with the London Electric Railway at Camden Town. It would involve an expenditure of about £2,300,000; but, though the improvement was a public need, he could see little likelihood of its being carried out until the financial position of the undertaking improved. Their railway was the pioneer of its kind in this country, but, if it was to be an effective instrument in dealing with the traffic of London, it must be reconstructed and modernised. That could not be done without a reasonable assurance that those who ventured their money had a chance of securing a fair return. All that was available for dividends upon a total capital of £20,113,420 of the combined companies was £496,387, or less than 2½ per cent. If they took into consideration the Government subsidy, and made adequate allowance for the depreciated value of the equipment, and a return of 4 per cent. was assumed on the capital, the actual loss sustained last year would have amounted to £1,274,629. A situation such as that could not continue indefinitely, and the directors, in consultation with the boards of the other associated railway companies, had submitted a Bill which sought to obtain additional powers to charge fares, the abolition of workmen's fares, and some relief against the passenger duty. Their own company possessed the power of increasing fares, but, in preference to acting on them, they were waiting to join in with a general scheme, in the hope that there would be established in London a system of fares more or less upon a uniform basis. He thought the people of London using those undertakings would be prepared to pay such a fare as would be necessary to pay for the service received, including a return upon the money invested.

When presiding over the meeting of the London Electric Railway Company, Lord Ashfield said they were only paying a dividend of 1⅝ per cent. (against 2 per cent. in 1918), a very unsatisfactory result. The directors had authorised the purchase of 40 new carriages at £117,700, but other improvements had to be held in abeyance. The proposed connecting railway at Camden Town would permit the introduction of a through service from the Hampstead and Highgate Railway to the City & South London Railway, necessitating the reconstruction and re-equipment of the latter. That was a much-needed additional traffic facility, but it was impossible to proceed with it at present. Having referred at some length to traffic facilities, fares, &c., he said that in order to meet depreciation and to pay 4 per cent. to the shareholders the cost per passenger worked out at 2·42d. per passenger, against the actual receipt of 2·04d. Labour costs had increased 173 per cent. since the war began, coal 182 per cent., and petrol 280 per cent. Unfortunately, the ratio of working expenses to gross receipts for 1920 was even higher than for 1919. The company had, therefore, agreed with its associated companies to promote a Bill to increase fares, &c.

At the meeting of the Metropolitan District Railway Company, Lord Ashfield said the dividend was 1 per cent. less than in 1918. On each passenger there had been an actual loss of 0·07d., and if they had regard to the necessity for making adequate allowances for depreciation and for the increased cost of all equipment, and were further to consider the interests of the shareholders, and assume a return of 4 per cent., then the actual loss during the past year would have been 0·38d. per passenger. No undertaking could continue indefinitely on such a basis, and therefore they were appealing to Parliament for relief. They were asking for wide powers to cover contingencies, but their object was to make only such a charge to the public as would secure sufficient revenue to pay the actual working expenses and give a fair return on the capital.

At the meeting of the Central London Railway Company, Lord Ashfield also referred to the need for increasing fares, &c. It was proposed to obtain power to extend the railway from its present terminus under the Uxbridge-road so as to link up with the Kensington and Richmond branch of the London & South Western Railway at a point near that company's Shepherd's Bush station. The capital for the construction of the line (just under 1 mile), including the acquisition of rolling stock, is proposed to be raised by the issue of £374,000 debenture stock, with power to raise any preference stock already authorised.

New Companies.

CAVAN ELECTRIC LIGHT & POWER COMPANY, LTD (4,895)—Private company. Reg. in Dublin Feb. 4, capital £4,000 in £1 shares, to carry on the business indicated by the title. First directors are H. McCauley, A. McCarren, J. F. O'Hanlon, R. Cinnamond and J. Cullen. Secretary: P. Reilly. Reg. office: Main-street, Cavan.

HACKBRIDGE ELECTRIC CONSTRUCTION COMPANY, LTD. (163,753). Private company. Reg. Feb. 6, capital £25,000 in £1 shares, to carry on the business of electrical, mechanical and general engineers, manufacturers of and dealers in transformers, radiators, dynamos, motors and electric power and transmission plant, &c. C. W. Bloomfield is permanent governing director. Reg. office: London-road, Hackbridge, Surrey.

HUBERT D. CARTER (BANGOR), LTD. (163,797).—Private company. Reg. Feb. 7, capital £5,000 in £1 shares (2,000 preferred), to carry on the business of electrical, motor and mechanical engineers and consultants, dealers in electric and other plant, &c., formerly carried on by H. D. Carter at 249, High-street, Bangor. First directors are H. D. Carter (governing director) and E. P. Carter.

LONDON MICA & GENERAL SUPPLY COMPANY, LTD. (163.926)—Private company. Reg. Feb. 11, capital £1.000 in £1 shares, to take over business of mica and general merchant carried on by S. Grout as the

SYDNEY ANDERSON, LTD. (163,783).—Private company. Reg. Feb. 6, capital £1,000 in £1 shares, to carry on the business of electricians, motor and mechanical engineers, &c. Reg. office: Wellesley Works, Wellesley Court-road, Croydon.

SYMINGTON (LANARKSHIRE) ELECTRIC SUPPLY COMPANY, LTD. (10,948).—Private company. Reg. in Edinburgh Feb. 5, capital £2,000 in £1 shares, to carry on the business of electrical engineers, electricians, contractors, manufacturers of electrical apparatus, &c. First directors are J. Cassels, D. A. Hay (and secretary), T. Duncan, J. C. Jarratt and J. W. McDonald. Reg. office: 105, St. Vincent-street, Glasgow.

TAXI-CALLS, LTD. (163,558).—Private company. Reg. Jan. 31, capital £1,000 in £1 shares, to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in electrical and mechanical devices, &c. Reg. office: 123, Pall Mall, S.W. 1.

TELEPHONE INSTALLATIONS (LONDON), LTD. (163,690).—Private company. Reg. Feb. 4, capital £2,000 in £1 shares, to carry on the business of manufacturers and installers of private telephone systems, &c. Reg. office: 14, Snow-hill, Birmingham.

UBIQUE WELDING COMPANY, LTD (163,263).—Private company. Reg. Jan. 24, capital £2,000 in £1 shares, to carry on the business of metal welders, engineers, machinery manufacturers, &c. First directors are: F. L. Lane, W. H. Dallow and W. R. Roberts. Reg. office: Stanley House, Moor-lane, Sale, Ches.

London Mica & General Supply Company. First directors are S. Grout, F. A. Smith and W. Beaumont. Reg. office: 351, Upper-street, Islington, N.

MAYFAIR LIGHT & POWER COMPANY, LTD (163,836).—Private company. Reg. Feb. 9, capital £1,000 in £1 shares, to carry on the business of electrical engineers and contractors, electricians, suppliers of electricity, &c., and to adopt an agreement with H. Meekhonik. First directors are H. Meekhonik, A. Meekhonik and H. M. Williams. Reg. office: 135, Edgware-road, W.

MECHANICAL PRODUCTS, LTD. (163,927).—Private company. Reg. Feb. 11, capital £10,000 in £1 shares, to carry on the business of electrical and mechanical engineers, manufacturers of electrical and mechanical plant and accessories, &c. First directors are T. Thompson and H. H. Oxley. Reg. office: 60-61, Blackfriars-road, S.E. 1.

NEWTOWNBARRY ELECTRIC LIGHT COMPANY, LTD. (4,873)—Private company. Reg. in Dublin Jan. 9, capital £3,000 in £1 shares, to carry on the business indicated by the title. First directors are R. W Hall-Dare, N. Thackery, D. Lennon, D. E. J. Lawlor and G. Lewis (and Secretary). Reg. office: Newtownbarry, co. Wexford.

RADIO PRESS, LTD. (164,035) Private company. Reg. Feb. 13, capital £100 in £1 shares, to carry on the business of proprietors and publishers of newspapers, journals, books, &c., dealing with radio-telegraphy and telephony, submarine signalling, &c. Reg. office: 34, Norfolk-street, W.C.

STONEYCROFT ELECTRICAL WORKS, LTD. (163,831).—Private company. Reg. Feb. 10, capital £3,000 in £1 shares, to take over the business of a general electrical and engineering contractor carried on by F. S. Ormonde at 20, St. Anne-street, Islington, Liverpool, as the Stoneycroft Electrical Works. First directors are F. S. Ormonde, E. C. Day and A. Huntington.

UNITED ARC WELDING COMPANY, LTD. (163,939).—Private company. Reg. Feb. 11, capital £5,000 in £1 shares, to carry on business as indicated by the title. First directors are W. E. Groves, H., C. Lumsden and R. Winskell. Secretary: C. L. Dobson. Reg. office: Ferry-street, South Shields.

UNITED WELDINGS & ELECTRICAL COMPANY, LTD. (104,293)—Private company. Reg. Feb. 19, capital £5,000 in £1 shares, to take over the businesses of electrical and oxy-acetylene welders, electrical and mechanical engineers, &c., carried on as the United Weldings & Electrical Company and as Robinson Bros. First directors are C. Robinson and C. H. Pearson (managing director). Reg. office: 3, Carter-street, Grenheys, Manchester.

WEST YORKSHIRE MOTORS, LTD. (164,097)—Private company. Reg. Feb. 14, capital £5,000 in £1 shares, to take over the business of a wire worker carried on by F. G. Brockway at Elland, and to carry on the same, and the business of manufacturers of and dealers in electric motors and dynamos, generating plant, &c. Reg. office: Providence-street, Elland, Yorks.

W. G. PERRY AND COMPANY, LTD. (163,943).—Private company. Reg. Feb. 11, capital £5,000 in 4,000 ordinary shares of 6d. each and 4,900 preference shares of £1 each, to carry on the business of electrical engineers, dealers in machinery, &c., and to adopt an agreement with W. G. Perry. First directors are W. G. Perry, F. W. Cook and A. Perry. Reg. office: 199, Westminster Bridge-road, S.E.

Prices of Metals, Chemicals, &c.

Tuesday, Feb. 24.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£128 0 0	—	—
Electro Wirebars...	,,	£131 0 0	£1 0 0	—
H.C. wire basis......	per lb.	1s. 5 7/16d.	⅛d.	—
Sheet.................	,,	1s. 6 9/16d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 9 7/16d.	⅛d.	—
***Brass* 60/40—**				
Rod, basis	,,	1s. 1d	—	—
Sheet, basis	,,	1s. 4½d.	—	½d.
Wire, basis	,,	1s. 4½d.	—	—
Iron—				
Cleveland Warrants	per ton	£9 2 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£43 0 0	£4 0 0	—
Lead Pig—				
English	,,	£53 5 0	£1 15 0	—
Foreign or colonial	,,	52 5 0	1 15 0	—
***Tin*—Ingot ....**	,,	410 10 0	21 0 0	—
Wire, basis	per lb.	0 5 1	3d.	—

Salammoniac.—Per cwt. 95s. and 90s.
Sulphur (Flowers).—Per ton £22.
,, (Roll Brimstone).—Per ton £22.
Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £48.
Boric Acid (Crystals)—Per ton £74
Carbon Bisulphide.—Per ton £56.
Sodium Bichromate.—Per lb. 9d.
Sodium Chlorate—Per lb. 6d.

Rubber.—Para fine, 2s. 7d.: plantation 1st. latex 2s. 9¼d. per lb.

Shellac.—T.N. Orange, 840s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the Rubber prices by W. T. Henley's Telegraph Works Co., Ltd.

Thirty-Seven Years Ago.

[From The Electrician, Feb. 24, 1883.]

A Contrast.—The cost of taking out an American patent for 17 years is about £7, whilst in England the same patent would cost about £200 for 14 years.

"The Electricians' Directory."—"The Electricians' Directory" for 1883 is now published, and may be had from this office, or through any bookseller. The price is 2s.

Royal Society.—On Thursday last Mr. W. H. Preece, F.R.S., was to read the following paper before the Royal Society, viz.: "The Effects of Temperature on the Electro-motive Force and Resistance of Batteries.

Electric Lighting on Trains.—The experimental lighting of trains running between Brussels and Antwerp has been put a stop to for a short period, to permit of certain modifications in the plant. It has been found difficult to obtain a sufficiently constant current, and it is with the object of insuring this that the temporary cessation of the lighting has been ordered.

An Army Telegraph Corps.—Lieut.-Colonel Du Plat Taylor, commanding the 24th (Post Office) Rifle Volunteers, has received instructions from the Secretary of State for War to form an army telegraph corps which might take the field in time of war. The nucleus of this "sister service" to the Army Postal Corps is a company raised principally from the Postal Telegraph Branch, which will be recruited to a strength of 200 rank and file, and supplied with the necessary field equipment.

Electric Lighting in Sunderland.—A trial of Gulcher arc lamps has lately been made at Lambton Drops, Sunderland, where the operation of loading coal vessels is carried on. The trial has so far been very successful enabling vessels to be loaded long after dark, or in fact, all night long if required. The dynamo, a Gulcher, is driven by one of Tangye's high-speed vertical engines. The Gulcher, like the Edison, is a low tension system, and in all cases where ordinary labourers having no knowledge of electricity are liable to come into contact with wires or lamps, this is a consideration.

The Electric Light in Shops.—The practical application of electricity to the lighting of shops is being shown on the premises of Messrs. Robinson & Sons, Italian Warehousemen, Upperhead-row, Leeds. Two storage batteries are used to feed a series of incandescent lamps, the current to which passes through a number of automatic commutators encased in a box, and by means of which the current is divided, so that it may be carried into distant parts of the building. All risk of accidents from fire caused by a sudden interference with the even flow of the current is removed by plugs, which will, at a temperature of 205 deg. Fahr., release the switch of the commutator and secure another and, under ordinary circumstances, more perfect connection.

The Inventors of Dynamos.—The following list of the best known names of inventors of dynamos will be interesting: Brush, American; Bürgin, Swiss; Edison, American; Elmore, English; Elphinstone & Vincent, English; Ferranti (we do not know Mr. Ferranti's nationality, but we do not think he is English); Gordon, English; Gramme, French; Gülcher, Austrian; Higgs, English; Hopkinson, English; Jablochkoff, Russian; Lumley (the inventor of the dynamo known as the "Lumley" is an American, we believe); Maxim, American; De Meritens, French; Pilsen, Austrian; Schückert, German; Fein, German; Siemens, German; Weston, American; Wilde, English. Reducing this list to numbers, we get the following figures: American inventors of dynamos number 5, Austrian 2, English 6, French 2, German 3, Russian 1, Swiss 1 and 1 doubtful (Ferranti). Summing up these figures give us 15 foreign inventors of dynamos against 6 English. It says something for England, however, that nearly all these 15 dynamos are to be found in London, and most of them are made there.

Benn Brothers Journals.

In "Aeronautics" the following special articles appear:—"Flying as a Sport"; "Rigid Airships and their Development"; "The Aeroplane in Desert Warfare."

"The Cabinet Maker":—"Furnishing of the Bush Terminal Building, New York"; "The Grading of Home Grown Timber for Cabinet Trade"; the "Golden Measure" or Greek Theory of Proportion; and "Practical Upholstering of Easy Chairs: the Treatment of Semi-Circular Backs."

"The Chemical Age":—"The British Fine Chemical Trade," first of a series of articles reviewing war-time developments and discussing future prospects: "Catalysts from an Industrial Standpoint," by Dr. Maxted; and Chemical Exhibits at the British Industries Fairs.

"The Fruit-Grower":—"Bird Habits in Relation to Food Production"; "Co-operation according to the A.O.S."; Reports from the Growing and Distributing Centres.

In "The Gas World" special attention is given to several important gas companies; and the post-war financial position of the industry is discussed. The text is also given of a Bill to facilitate gas companies issuing capital under post-war conditions.

"Hardware Trade Journal," Empire Number: Indian Trade Development; illustrated articles on the British Industries Fair; "The Film as a Factor in the Development of Overseas Trade," by Arthur Finch; and Japanese Competition.

"Ways and Means":—"United States War Finance and After" (II.), by Prof. Edmond E. Lincoln; "Talks about Work and Wages" (VII.); "Money: What it is and How it Works," by the Editor; "Food Prices," by Mr. Boyd Cable; and "Sex Warfare in Industry," by Dr. Lionel Tayler.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861

No. 2,181. [No. 10. Vol. LXXXIV.] FRIDAY, MARCH 5, 1920 PRICE ONE SHILLING. *By Post, 1s. 1d. Abroad, 1s. 2d.*

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Notes.

Electricity Supply and the Textile Industry.

THIS week's issue of THE ELECTRICIAN contains a mass of documentary evidence showing what has been done in the application of the electric motor to the driving of textile machinery. We have no doubt that, like other special issues which we have published from time to time, it will attract immediate interest and remain a record to which constant reference will be made. In our Leading Article we deal with certain points raised by the contributors to this issue. And in so doing we have tried to show the effect that the introduction of electrical apparatus is having on the development of the textile industry. But the effect the load provided by textile mills is having on the electrical industry is equally important and is worth a few moments study. It is generally admitted that, where it is possible, the textile mill owner has everything to gain by obtaining the electrical energy he requires from the public supply mains. It is not, of course, given to every supply engineer to have textile mills in his area, but those who are so fortunately placed have also the responsibility of making the manufacturer see the advantages obtainable by the use of the electric drive. Much has been done in this direction, but there is yet a great deal to be done. Nevertheless the developments are gratifying and the £2,000,000 capital issue of the Yorkshire Electric Power Company and the linking-up of the various undertakings in South-East Lancashire are in their way both portents of a satisfactory future in this respect.

The Manufacturers' Responsibility.

THERE are, however, cases where the textile mill owner cannot with the best will in the world obtain his electrical energy from a public supply, but that is no reason why electrical engineers should lose interest in his case. For he can be persuaded to instal his own generating plant and, being, like every textile engineer, a keen economist, he will be interested to know all about the latest developments in firing such as powdered fuel and the advantages obtainable by the use of mechanical stokers, not to speak of other similar factors which have been designed to reduce the cost of producing electrical energy. He will make inquiries as to efficiency and operation of steam turbines with outputs of say 2,000 H.P. and do all he can to learn which are the best designs of alternators and switchgear. The responsibility for increasing the use of the electric drive in textile factories does not therefore rest solely on the supply engineer, but must be shared by those who sell and design electrical plant. This issue will, we feel, show them what the requirements of the textile manufacturer are and help them to supply his needs.

More About the London Electricity Joint Committee.

IN last week's issue we commented on the formation of the London Electricity (Joint Committee), 1920, Ltd., whose object, among other things, is "either alone or in conjunction with others to act as . . . a Joint Electricity Authority" for London. In so doing we deprecated the idea that there should be any partisanship in the development of electricity supply in London, and expressed the hope that both the municipal and company authorities concerned would realise the necessity of pooling their interests for the common good. At the meeting of the St. James's & Pall Mall Electric Light Company more was heard about this company. Mr. WALTER LEAF told the shareholders that it was intended "to form the nucleus of a general combination of all London companies. That the municipal authorities had got a scheme of their own." At the meeting of the Westminster Electric Supply Corporation, Mr. J. BROWNE MARTIN said "they had associated themselves with other London companies in putting forward a scheme for the supply of electricity to the London area." It will be noticed that in neither case is anything said about combination with the municipalities. But we are informed by Mr. W. A. PEARMAN, secretary of the new company, that one of its objects is to "collaborate with reference to the supply of electric energy . . . with any County Council or other Local Authority." That being so, why did not those worthy chairmen whom we have quoted say so more definitely. Is it because they felt their shareholders would be shocked at any show of friendship towards municipally-owned undertakings or is it because the clause has been put in just to make combination possible should the other policy fail? We sincerely hope that neither of these explanations is the correct one, for, in our opinion, it is most essential that no stone should be left unturned to bring what can, unfortunately, only be called a state of misunderstanding between privately and publicly owned undertakings in London to a close and to inaugurate a new era when both will work together for the good of London's electricity supply.

Works Committees.

The Whitley scheme, it will be remembered, was pyramidal in form and consisted of three tiers. The bottom tier was the Works Committee, the second tier the District Industrial Council, and the top and crowning tier the National Industrial Council representing the whole industry in question. As regards the electricity supply industry, the two top tiers are well on the way to completion. The National Council is nearly appointed, some of the District Councils are formed, others are in rapid course of formation. So far so good. But what of our third estate, the Works Committees. How many of these are there as yet in existence? Very few, we are afraid. And yet the Works Committees are an integral part of the scheme. It is only through them that the actual workmen are individually brought into the scheme at all. The basic idea of the scheme is, in fact, to strike the personal note, to make every employee in the industry take a direct and intelligent interest in all questions concerning the general welfare. Not only this, but to give every employee some voice in directing affairs and an opportunity to suggest improvements and freely to express opinions. The Works Committee is the working organisation on this side of the scheme. All questions individual to the particular undertaking can be settled straightway. But if they affect other undertakings, then the opinions of the several Works Committees are discussed in the District Council, or if not settled there are taken to a higher court, when the whole country's views can be discussed in the National Council. It cannot, therefore, be too strongly urged that Works Committees should be formed everywhere without delay. A speaker at the recent conference of Manufacturers and Producers gave striking testimony to the value of a Works Committee. He spoke warmly of the new spirit that animated the whole of the works, entirely owing to the Committee. It will, we presume, be one of the first duties of the District Committees to take a census of the Works Committees formed in their areas, and we hope, like Father O'Flynn, they will do something towards "helping the lazy ones on with th' stick."

The Problem of High Prices.

The problem of how to reduce the present universal high prices is now rather belatedly receiving attention from the Peace Conference assembled in London. The questions under consideration include rates of exchange, scarcity of commodities, transport, production, trusts, profits and taxation. The agenda is a long one and we shall await the results with interest for the time for academical discussion of these absorbing subjects has past and the time for action has arrived. On the same day that the Peace Conference began its sittings Sir Auckland Geddes spoke on this same question of high prices at a luncheon given by the Association of Trade and Technical Journals, his object being to enlist the assistance of the organs there represented to put before the public the exact truth regarding high prices. Everyone knows prices are high. But what are the causes? According to Sir Auckland they are the currency position, general scarcity, shortage of essential commodities and, in a relatively minor degree, that form of exploitation known as profiteering. He might have also added, what in our opinion is the most important cause of all, the inability of nations, no less than persons, to realise that for financial stability they must live within their means.

How They Can Be Lowered.

Sir Auckland further pointed out that while we referred everything to the value of gold that value had itself fallen during the past five years and the prices now ruling were, as we know to our cost, paper prices. The first essential is then to close the gap between gold and paper prices by bringing down the one or raising the other or by a combination of both methods. This in itself would lead to some reduction in prices, though it could not be hoped that they would reach their pre-war level, and there would, therefore, have to be a permanent economy in gold for monetary purposes. Scarcity could be relieved by greater production and profiteering must be rigorously stamped out wherever it was found. We are glad to see that Sir Auckland realised that any direct action on the part of the Government would hamper rather than assist progress in this direction, and that his panacea for the present terrible state of affairs is less consumption, more production and harder work. As far as *intelligentia* of the electrical industry is concerned, Sir Auckland was, of course, preaching to the converted. We realise that relief can only come by the modern equivalents for the old remedies of prayer and fasting. There is not one of us that is not working harder to-day than we ever were before and working, it almost seems, with less result. But what we do not realise is why, if economy is so necessary for private individuals, it is not equally necessary for Governments and municipalities, and for those individuals whose remedy for high prices is apparently the indefinite increase of wages. It is all very well and very easy to preach economy, but we should like as a change to see a little practice, an abandonment of State socialistic schemes for this and that, a rigorous pruning of the bureaucrats and a Parliament determined on saving rather than spending money. Sir Auckland referred to a goose that ate its own eggs, we know of another for which the sauce is the same as that for the gander. At the moment we are more interested in the latter bird.

The Price of Petrol and the Electric Vehicle.

According to the report published this week the Central Profiteering Committee has at last found an article in the sale of which profiteering is taking place. Powerful financial interests are taking advantage of the deficiency of motor fuel to raise prices and as has been suspected at the present prices an exorbitant profit is being procured by both the producer and refiner. It is considered that No. 1 petrol should be retailed at 2s. 10½d. per gallon and No. 3 at 2s. 8½d., while the price of benzol should be fixed at 2s. 8d. per gallon and its export prohibited. This, of course, is all very well and is to be commended in so far as it prevents the many from being exploited by the few, and alleviates to some extent the drag that is being placed on trade by the high cost of transport. But it is only a remedy and not a cure. The basic fact is that there is a world famine in motor spirit and that fact is not going to be altered by any form of control. Some substitute for petrol is necessary. Alcohol is suggested. But what about electricity? Wordsworth's happy warrior turned his own necessity to glorious gain. In the high price and great shortage of petrol there seems to be a good chance for the electric vehicle and electricity supply industries to turn a nation's necessity to their own advantage and at the same time to confer great benefits on the community.

The Lighting of Mines and Miners' Eyesight.

Conditions in mines are receiving a great deal of attention from the public just now, and the discussion before the Illuminating Engineering Society on February 24 was therefore timely. The introductory paper by Dr. Llewellyn dealt chiefly with the effect of peculiar conditions of illumination in mines on the eyesight of miners, especially as a factor in causing the disease known as nystagmus. A number of medical men from mining districts expressed their views at the meeting, and there seems little doubt that inadequate lighting is regarded as the chief cause of this disease, which is said to be responsible for an economic loss of some millions of pounds every year. Dr. Llewellyn was able to support his conclusions by unusually comprehensive data on illumination. He suggests as a tentative standard an illumination on the coal face of 0·1 ft.-candles. It is probable, however, that the distribution of the lighting is quite as important. In the course of the discussion the suggestion was made that a complete study, both of eyesight returns and of conditions of illumination, should be made in the mines in this country by a joint committee on which both ophthalmic surgeons and photometric experts would be represented. Certainly, we need much fuller information on this complex problem than is available at present. We have first to determine the actual conditions of lighting responsible for the disease, and information to ascertain how far the requirements can be realised in practice. The second problem may prove the more difficult of the two, and one could not expect results too quickly. The whole question is a most important one, and we are glad that the Illuminating Engineering Society is bringing it before the notice of the authorities.

Two Years More.

The announcement of the official date of the termination of the war with Germany is a reminder that the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, is one of those Acts which will still run on, in this case for "two years thereafter and no longer." The Act has been anything but an unequivocal success. It has been good and bad mixed. It enabled any undertaking that had been adversely affected by the war to apply for power to increase their charges, but limited them thereafter to pay at most only three-quarters their pre-war dividend. But the Board of Trade, directly the Act was passed, took the view that they were precluded thenceforth from dealing with the five-yearly applications for increase of prices made in the normal course under the Electric Lighting Acts. So companies who had fulfilled their five-year period were, by this boomerang effect of the new Act, unable to use their proper privileges under the Electric Lighting Acts.

Current Topics.

This issue of The Electrician is the second that deals specially with the application of electricity to textile mills, the first having been published on November 17, 1911. In this issue the following articles are published :—

"The Present Position of the Lancashire Cotton Industry," by Mr. Frank Nasmith (p. 240).

"The Principles of Manufacturing Textile Goods from an Engineering Point of View," by Messrs. W. Myers and W. A. Hanton (p. 244).

"The Cotton Industry of the United States," by Mr. Frank Nasmith (p. 249).

"Textile Mill Equipment : Its Advances and Systems," by Mr. C. S. Iekringill (p. 254).

"Some Notes on Lighting in the Textile and Clothing Industries," by Mr. J. S. Dow (p. 260).

"The Development of Electricity Supply to Textile Mills," by Mr. W. Browning (p. 263).

"Gas Engines for Textile Mills," by Mr. J. G. Walthew (p. 266).

"Transmission and Distribution of Electricity in Textile Mills and Works," by Mr. Walter T. Reynolds (p. 268).

"Electricity Supply in Dundee Textile Mills," by Mr. C. Lamb (p. 270).

"Application of Electricity to Textile Mills in India," by Mr. J. Knowles (p. 272).

"Electricity Supply to the Bolton Textile Works," by Mr. W. J. H. Wood (p. 274).

"The Electrification of a Large Scotch Works and Mill" (p. 276)

"The Oerlikon Individual Drive for Ring Spinning and Twisting Frames" (p. 277).

"Electrification of Textile Mills" (p. 277).

Our Leading Article this week deals with "Electrification and the Textile Industry" (p. 273).

Arrangements for the Week.

FRIDAY, March 5th (to-day).

Institution of Electrical Engineers.—Students' Meeting.

7 p.m. At the City and Guilds (Engineering) College, S. Kensington, London, S.W. Address by the President, Mr. R. T. Smith.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Notes on Gauge Testing and Measuring Appliances," by Mr. F. H. Rolt, B.Sc.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. At the University, Sheffield. Paper on "Flat Plates," by Mr. C. C. Pounder.

7.30 p.m. At the Technical School, Barrow-in-Furness. Lecture on "Gearing Design," by Mr. M. Coronel.

SATURDAY, March 6th,

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "Positive Rays," by Prof. Sir J. J. Thomson, O.M. (Lecture III.)

Junior Institution of Engineers—North Kent Section.

7 p.m. At Dartford Technical Institute, Dartford. Paper on "The Application of Variable Speed Polyphase Motors," by Mr. A. Smith.

MONDAY, March 8th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "Modern Developments of the Miners' Safety Lamp," by Sir John Cadman, K.C.M.G.

TUESDAY, March 9th.

Royal Institution.

7 p.m. At Princes-street Station Hotel, Edinburgh. Paper on "The Protection of Alternating Current Distribution Systems without the Use of Special Conductors," by Major K. Edgcumbe.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. In the Arts Building, The University, Liverpool. Lecture on "Elementary Calculus," by Mr. S. Clowes.

7.30 p.m. At the Grammar School, Chesterfield. Paper on "The Principles and Design of Centrifugal Fans," by Mr. F. Clements.

Institute of Metals.—Birmingham Local Section.

7.30 p.m. At Chamber of Commerce Buildings, New-street, Birmingham. Paper on "The Amorphous Phase Theory and Its Applications," by Mr. O. W. Ellis, M.Sc.

WEDNESDAY, March 10th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "Petroleum and the War," by Sir John Cadman, K.C.M.G.

Industrial League and Council.

5.15 p.m. At the Carpenters' Hall, Throgmorton-avenue, London, E.C. Lecture on "Industrial Unrest and Whitley Councils," by Mr. G. J. Wardle, C.H., M.P.

7.30 p.m. At Central Hall, Westminster, London, S.W. Subject : "Should Wages be Lowered ?" by Mr. E. J. P. Benn.

Association of Engineers-in-Charge.

7.30 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "The Solidification and Crystallisation of Metals," by Mr. L. Aitchison.

THURSDAY, March 11th.

Institute of Metals.

4 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Annual General Meeting.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. Papers on "Notes on Operating a By-Product Producer Gas Plant for Power and Heating," by Mr. W. H. Patchell ; and "Production of Power from Blast-Furnace Gas," by Mr. S. H. Fowles.

Institution of Automobile Engineers.—Graduate Section.

8 p.m. At 28, Victoria-street, London, S.W. Paper on "Magnetos," by Mr. C. A. Chappell.

FRIDAY, March 12th.

Institute of Metals.

10.30 a.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Annual General Meeting.

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers : "Absorption of Gases in the Electric Discharge Tube," by Mr. T. W. Newman, B.Sc. ; "A New Directional Hot Wire Anemometer," by Mr. J. S. G. Thomas, M.Sc. ; and Exhibit of a New Micro-balance by Dr. Hans Pettersson.

University College (London) Engineering Society.

5.30 p.m. In the Botanical Theatre, University College, Gower-street, London, W.C. Annual Public Meeting. Address on "Coal Conservation," by Sir Dugald Clerk, D.Sc., F.R.S.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Chain Helice Pumps," by Mr. F. A. Simpson.

Present Position of the Lancashire Cotton Industry.

Interesting Information on a Matter of Vital Importance.

By FRANK NASMITH.
(Editor of the "Textile Recorder.")

THAT we are living in remarkable times is a truism that can aptly be applied to the cotton industry of this country. For four and a half years the world has been deprived of its full and adequate supply of cotton goods, with the result that the whole of the markets of the world are depleted. It must always be remembered that 80 per cent. of the clothing of the world is cotton, and that prior to the war the extension in the use of such goods was increasing steadily. From Lancashire was exported some 80 per cent. of the total products of the spindles and looms of that county, the remaining 20 per cent. being used in the home market. The position in the United States was entirely different, because a home market of some 110,000,000 people practically monopolised the output of the American textile mills. India, China, the Levant, Turkey and Africa bought largely from Lancashire.

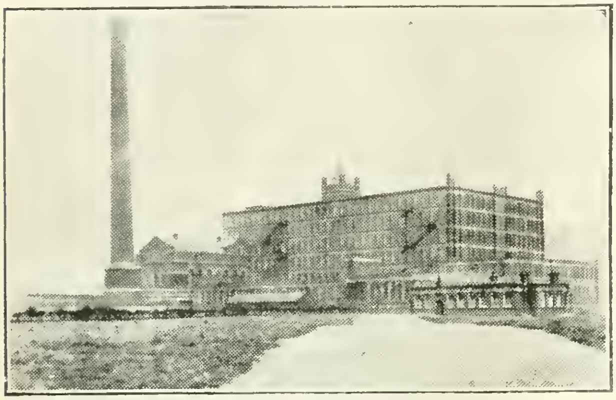


Fig. 1.—Exterior of a Typical Lancashire Spinning Mill.

In the City of Manchester one can find shipping houses with curious foreign sounding names, a large foreign population whose business it is to act as the buying agents for their distributing houses which are located throughout the globe. Hitherto, the trade has been largely brought to Manchester, and there has been little difficulty in maintaining our markets throughout the world. With what has amounted to four and a half years' restriction in exporting, there is a clamorous call from overseas for Lancashire goods, with the result that spinning and weaving mills have full order books for many months to come. Provided delivery can be given, buyers will pay almost any price for fabrics, and all our old-time ideas have had to be remodelled. The price of raw material has risen to a height that would have been considered impossible in 1911. In fact, the majority of those engaged in the industry would not have credited it possible to do business at the prices ruling to-day, and the old-time cry that Lancashire must produce cheaply for the poor natives of India and China has received its quietus during the past few months. As will be shown later, the cost of machinery, buildings and power plant has also been advanced tremendously, and consequently there has been a boom in mill buying. Re-capitalisation was essential if the ordinary business was to be carried on—in order to finance it at the enhanced prices—but the other factors of increased cost of machinery and buildings with the added one of advanced delivery for such machinery and the delay in building have inflated the values of mills generally.

The boom in cotton mill buying commenced in April, 1919, when the Pine Mill, at Oldham, was bought for £135 per share. This mill has 121,000 spindles, and without taking into account the fact that no doubt a good deal of stock was purchased, the price per spindle—a little over £1—was extremely low at

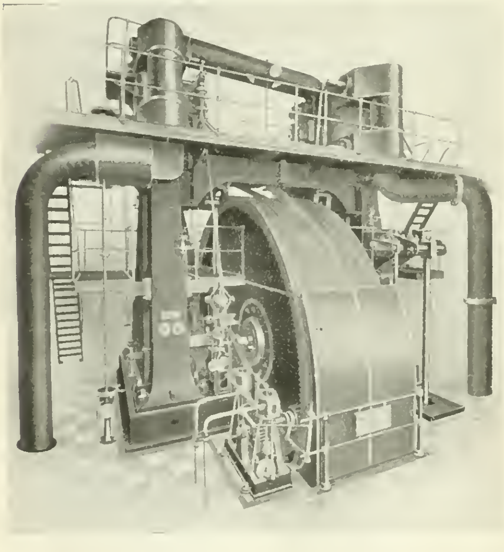


Fig. 2.—Inverted Vertical Cross Compound Steam Engine.

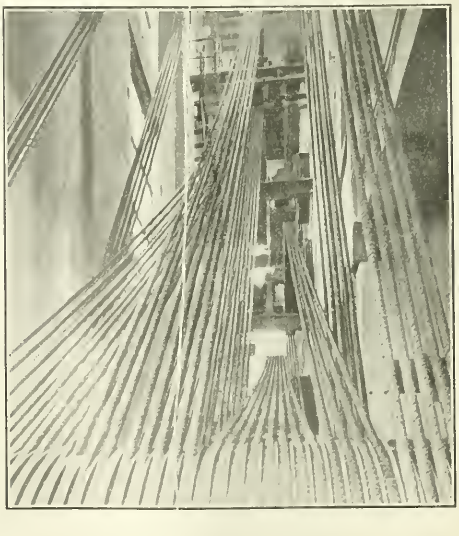


Fig. 3.—Kershaw Leese 2,300 b.h.p. Turbine and Gearing Showing Rope Drive.

present rates. Since that time more than 120 spinning mills have been bought, while one hears of re-organisation in other directions. Although it may be true that some of these mills have been bought above their true value, we do not think that many transactions of this character have taken place, and no doubt the promoters are looking to the next five years of good trade in which to get their money back. The largest deals have been that of Horrockses, Crewdson, a £5,000,000 flotation, and at the time of writing, the Crosses & Winkworth deal of £3,000,000.

Careful investigation would prove that many of the mills have been bought at a price at which they could not be replaced to-day, and the only consideration is the condition of the machinery which has been running for four and a half years with no chance of renovation.

Turning now to the cost of machinery, figures obtained give the following :—

	1914.		1919.
Mule Spinning Mill............	25/-	...	70/- per spindle.
Ring Spinning Mill............	50/-	...	140/- ,, ,,

It will be understood that such prices cover the total cost of the mill—*i.e.*, land, buildings, machinery, power plant, &c.

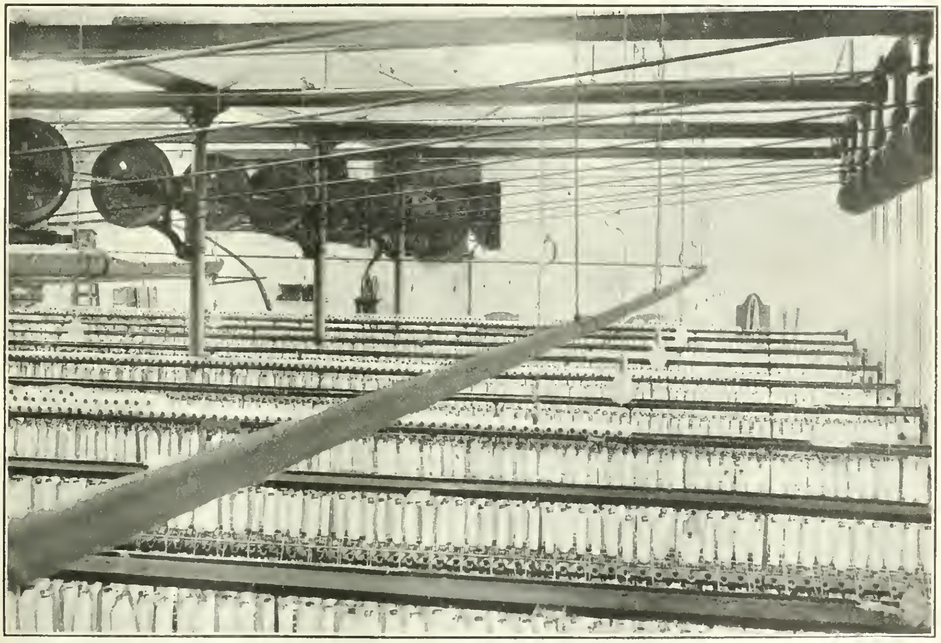


Fig. 4.—250 b.h.p. 485 revs. Alternating Current Induction Motors Directly Coupled to Live Shaft Driving Ring Spinning Frames on the top Floor of 5-Storey Cotton Spinning Mill.

Anything up to 350 per cent. increase has been placed on textile machinery. Looms, for example—a plain overpick loom, costing before the war £8 to £10—are now selling at £32 to £40 a loom, and one can go through the whole range of machines, and also through the raw materials necessary, finding the same enormous advances. Farina, used for sizing, which was sold in 1914 for £12 to £14 a ton, to-day brings £54 to £56 per ton. No wonder that increased capital is required to-day, and that mills are being sold at such high prices.

Textile machinery depreciates just as other machinery—not so rapidly, perhaps—but it can be estimated that taking depreciation and the normal expansion of the trade the world was short some 20,000,000 spindles when the Armistice came. Can it, therefore, be wondered at that textile machinists were flooded out with orders? Delivery dates to-day are somewhere in the region of late 1922, and all the world almost is demanding spinning and weaving machinery. China, for example, is going ahead, and recent orders for that country have shown how real is the endeavour to increase home production. The conclusion one can arrive at is, that new mills in this country will be few during the next five years, and that existing mills will be working to their fullest capacity for many years to come.

In view of this statement, it is unfortunate, therefore, that there is a decided shortage of labour in Lancashire, and if the spinning mills are not very adversely affected, one hears of many weaving mills where looms are standing idle. This is, indeed, deplorable, and one seeks a solution. The inferior and comparative scarceness of labour in the United States forced the manufacturers to adopt labour-saving devices, including automatic looms. An automatic loom is one in which the replenishment of weft is effected automatically, and the weavers maintain a full supply of such weft in the magazine. We have never taken kindly to automatic looms in this country, and after a campaign of 15 years the total number of automatic looms running in Great Britain on cotton goods in 1914 was only 12,000 out of 750,000. During the war very few looms were made, and about a couple of hundred to this figure would cover the addition. Since the war orders for 5,000 have been placed, which shows a very considerable expansion, and is a striking commentary on the new conditions. Recently the writer was informed that the order for looms on which the tyre fabric of the Dunlop tyres is made was placed with an American firm, who will supply automatic looms.

There are many machines in existence which will assist production, and it is very certain that we shall see the fullest use made of automatic and labour-saving machinery in the near future. Another factor—and an important one in the spinning mills—is the removal of the boys and girls who hitherto served so many useful purposes. This is a good thing for Lancashire and the country, but it will mean re-organisation in the mills and the eventual resource to labour-saving devices.

The decrease in hours has also naturally tended to reduce the output from spindles and looms. Talk of re-organisation is in the air along the line of removing duties from operatives which are non productive. Such work as carrying the cloth to the warehouse, bringing weft to the loom, &c., will be performed by auxiliary hands. In fact, it has been suggested and adopted in some mills -that special auxiliary gangs for cleaning, carrying, oiling, tackling and other duties be organised. The whole object is, of course, to increase the output per operative, and to bring this output to 100 per cent. efficiency. Wages have advanced 115 per cent. on the standard lists. It is a stated fact that the operatives to-day are not obtaining the production per hour they did when working the longer hours. This is indeed regrettable, and if any means can be brought forward whereby the operatives will get back to pre-war production it will be to the infinite good of the indus-

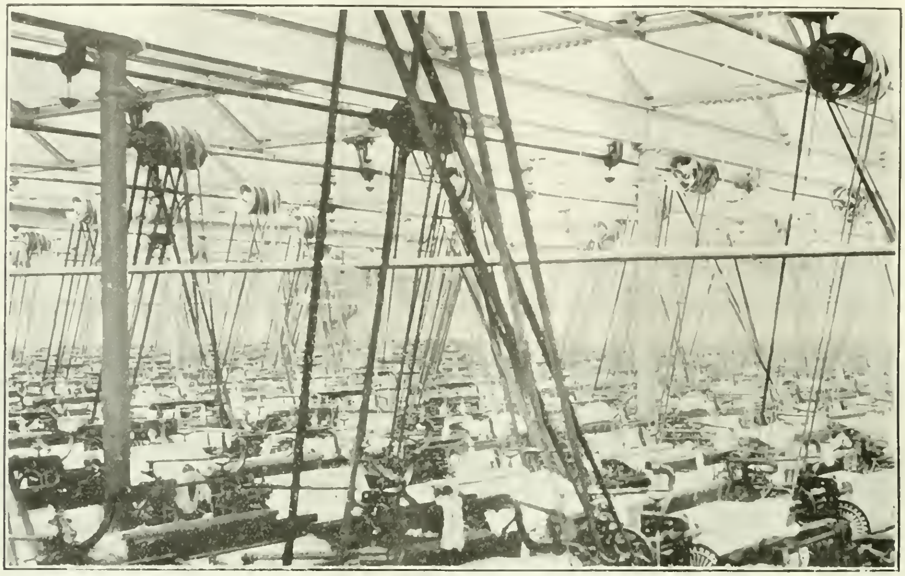


Fig. 5.- Weaving Shed—Plain Looms.

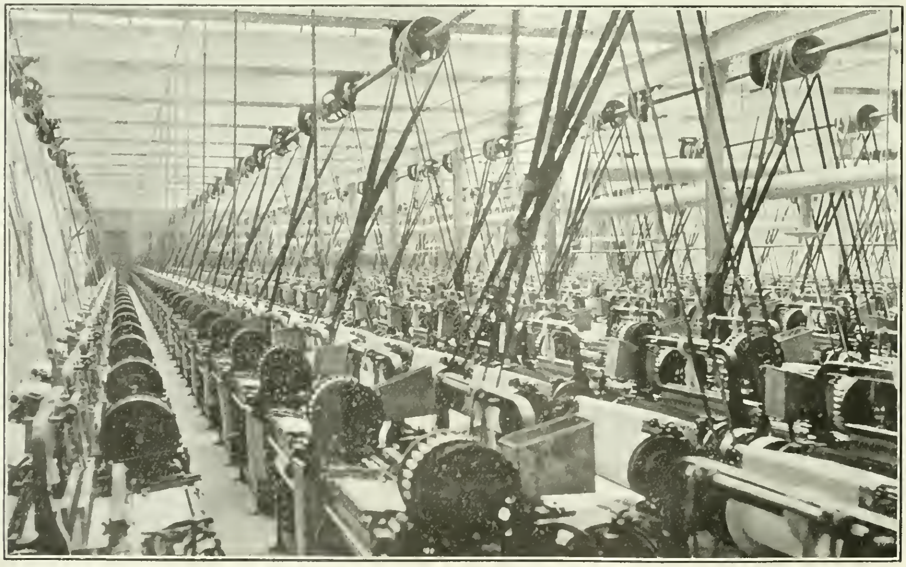


Fig. 6—Weaving Shed Northrop Automatic Looms.

try. There is another question which it may be advisable to deal with at this point, namely, the menace of a shortage of raw material. It is evident that Lancashire has to look very closely to the future and to provide against the possibility of a reduction in the amount of raw material imported from the United States. Various sources are suggested, expansion in some, development in others. The fact remains that America is consuming more of her own cotton every year, the demand for cotton goods is growing, and Lancashire is in the position that her supply of raw material has to be imported. The writing is plain, and it will be interesting to see what steps are taken in the near future to safeguard the supply.

It is not the province of the writer of this article to discuss the question of the electric driving of textile mills. That will be done in this issue by others. It may, however, be stated that there is not much likelihood of large extension in the near future. The mills are working at full capacity, and it is not conceivable that while they can turn out the material at the high prices ruling and demand so great that they will stop one moment to instal new power plant. Any conversion made will have to take place without interfering with the running of the machinery. This can be done. It is a curious commentary on the economical drive which is so typical of Lancashire mills the medium speed engine and the rope transmission—that even with all the propaganda work undertaken only 5 per cent. of the total spindleage is driven electrically, and only ½ per cent. of these spindles are driven by power purchased from power companies. The total spindleage is approximately 55,000,000. Many of the advantages claimed for the electric driving do not apply to Lancashire mills. If the mill is running, then every department is in full swing, and the running hours are constant, so that the value of departmental use is not of any moment. Regularity of drive is granted, and with automatic looms, particularly, such regularity is a great asset. The electrical engineers to-day who cater for textile driving understand their work thoroughly, and the writer firmly believes that more real research work in connection with textile machinery has been undertaken by electrical engineers during the past few years than has been accomplished by the textile machinist himself. It is a good sign, and no doubt will lead eventually to changes in textile machinery that may be revolutionary in character. One thing is very evident in regard to electric driving, namely, that in the future the current will be purchased and not generated at the mill.

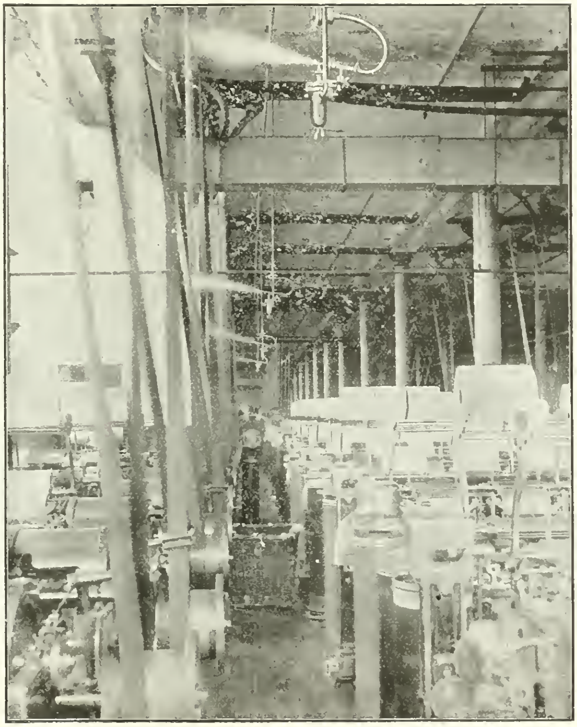


Fig. 7.—Humidifying Plant in Card Room of Lancashire Mill.

During the war there has been comparatively little machinery built, only that actually necessary for war work, and consequently no development. Recently one has come across new machines, but in the main these have been modifications of existing types and demonstrate no new principles. The writer is aware, however, of experimental work that is now being carried on which may result in entirely new types of machines. The co-operation of engineers of all kinds during the war will undoubtedly have a beneficial effect upon textile machinery; not only is it quite possible that minds fresh to the matter will introduce new ideas, but the present construction will be improved. Up to the present, textile machinery has been produced very cheaply. That day is past, and with it the slur we hope that looms, for example, were only foundry jobs. It is quite reasonable to believe the pneumatic and electrical forces will ultimately be employed in certain operations. For example, the present method of picking or projecting the shuttle from the shuttle box to shuttle box is non-positive and extremely wasteful in power. It has been proved that pneumatic force can be utilised to effect this, but in order to secure the result, the whole loom has to be re-designed, the shuttle consisting of a torpedo-shaped receiver, which, by the way, will carry a comparatively large quantity of weft.

Motor transport has been largely adopted in Lancashire, and with excellent results. As a matter of fact, many mills were kept working during the recent railway strike by the employment of this method of conveying raw material to the mills and finished product from them. In considering this matter, one must remember that the Lancashire mills are largely individual, that is, they either spin, weave, bleach, dye or finish. It is no uncommon thing for a motor lorry to take a load of cloth from a mill in Burnley to the Manchester warehouse, proceed to Oldham to pick up a load of yarn, and then proceed back to the mill the same day. By rail, days might be occupied in this transportation.

As regards foreign markets, there is no doubt that competition is becoming more severe, but there is no cause for alarm. One cannot accept, for example, the many extreme statements of Japanese competition seriously. At the best, Japan to-day has no more than three million spindles, and she has a large population to supply with cotton goods. In South America, before the war, certain markets were almost wholly German, but during the war excellent work has been accomplished there, and undoubtedly our trade has increased. The reconstructed Board of Trade with its Trade Commissioners and Overseas Department, are doing excellent work—work which should have been done many years ago.

Taking everything into account, provided we are not handicapped by labour disputes, Lancashire will still remain pre-eminent in the cotton industry. Even to-day there are many buyers from America imploring manufacturers to sell them fabrics. But Lancashire is now busy with her own customers, and there are years of good trade ahead.

Principles of Manufacturing Textile Goods from an Engineering Point of View.

Review of the Various Processes Involved.

By W. MYERS, M.Sc.Tech., and W. A. HANTON.

It is proposed in this article to deal only with the manufacture of cotton goods. The machinery and processes used in the treatment of linen, wool and other fibres differ to some extent from those used in cotton, but in many respects the principles involved are very similar.

Processes in Cotton Manufacture. Spinning.

Cotton fibres of the best quality are from 1½ to 1¾ in. long, those of common qualities from ¾ in. to 1 in. in length, and their diameter varies from about 0·0006 to 0·0008 in. The fibres, in cross section, resemble flattened tubes, and a marked characteristic is that each is twisted to the right and left many times about its longitudinal axis.

The spinner receives the raw cotton in a compressed bale in which the fibres are in a matted state and mixed with considerable impurities, such as broken seed, leaf and sand. The function of spinning is to convert this tangled mass of fibres into a thread suitable for weaving into cloth or for other purposes. The packed cotton from the bales is first broken up into a more open, fleecy mass, and this is usually done in conjunction with mixing, where broken up bales of cotton of slightly different qualities are mixed together in accordance with the kind of yarn to be produced. After mixing, the cotton is "opened," which consists of getting it into an open, loose state; in this process the greater part of the impurities are removed, and at the end of opening the cotton is in the form of a "lap" or roll of cotton, about 40 in. long and 16 in. diameter, and weighing about 12 oz. per yard.

The material is now carded, and at this stage many immature fibres, short fibres and small impurities are removed. A beginning is also made in arranging the fibres parallel to each other, and at the end of carding the material is in the form of a "sliver," an untwisted rope of cotton, about ¾ in. in diameter, coiled in a can about 9 in. diameter and 3 ft. high. Sliver weighs about 50 grains per yard. The best classes of cotton are combed at this stage, all short fibres being removed, but this combing is omitted in medium and lower class cottons, and after carding the cotton passes to the drawing process. The function of drawing is two-fold. In the previous processes care has been taken, so far as possible, to get the material uniform in weight per unit of length. This levelling up process is continued during drawing by "doubling" or bringing together about six separate carded slivers. At the same time drawing or attenuation of this mass is carried out by passing the material between four pairs of rotating rollers, each pair moving at a higher surface speed than the preceding pair, so that the resulting sliver is about the same weight per yard as one of the six card slivers which produced it. This drawing out process tends to bring the fibres parallel to the length of the sliver, the positions they must occupy before they can be spun successfully into a thread. This doubling and drawing process is usually repeated a second and a third time, and at the end of it the sliver is practically uniform in weight per unit of length, and the fibres are mostly parallel.

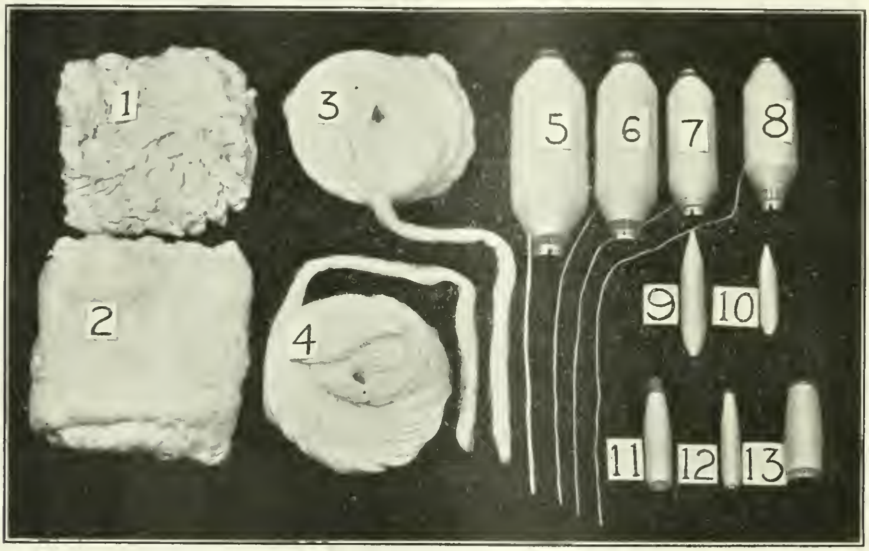


Fig. 1.—Cotton in Various Stages.

1. Raw cotton.
2. Opened cotton.
3. Carded sliver.
4. Drawn sliver.
5. Slubbing frame bobbin.
6. Intermediate frame bobbin.
7. Roving frame bobbin.
8. Roving frame bobbin.
9. Twist mule cop (for warp).
10. Pin mule cop (for weft).
11. Twist ring frame bobbin.
12. Weft ring frame bobbin.
13. Ring doubler bobbin.

The next process consists of drawing the material until it is sufficiently fine to be spun into thread. This has to be done gradually and a certain amount of twist has to be introduced to enable the material, now known as "roving," to be handled. It is in the form of a soft weak thread, varying in diameter from about ¼ in. at the beginning to about 1-16 in. or 1-32 in. at the end, and is wound in parallel layers on bobbins. Finally, this roving is spun in a spinning machine. The material receives a final drawing out, and is then twisted into a firm thread or yarn capable of standing the stresses to which it is subjected during weaving.

Throughout the spinning processes differences in treatment are made according to whether the yarn being spun is to be used for warp—the threads which run the length of the cloth—or weft—the threads running across the cloth. The former are subjected to a much greater tension and to greater wear during weaving than the latter, and must, in consequence, be stronger. This end is attained by a suitable selection of the raw cotton, by putting a greater number of twists per inch in warp than in weft yarn, and by coating the warp threads with size before weaving. Illustrations of cotton in various stages of manufacture are given in Fig. 1.

Processes Preparatory to Weaving.

Warp yarn requires considerable preparation after spinning before it is ready for weaving. Usually it is first transferred from the bobbin or cop of the spinning machine to flanged warpers bobbins on which it is wound in parallel layers. Then by one of several available warping processes it is wound, usually in two stages, on to the loom beam, on which the required number of warp threads for the cloth to be woven are placed side by side. At some stage in this warping process the yarn is sized by saturating or coating it with a preparation of starch, flour, &c. This treatment, after the yarn has been dried by passing it over the surface of a steam heated cylinder or through a hot air chamber, renders the yarn smooth and strong enough to stand the treatment it receives during weaving. The opportuntiy is also taken during the winding and warping processes to remove any weak places in the yarn and to get each thread into as good a condition as possible. After the threads have been wound on the loom beam they have to be placed in a position ready for weaving into cloth, that is, they have to be passed through the healds and reed. This may be done in two ways, first, by passing the threads singly through the eyes of the healds and in groups of two or more between the dents of the reed; this is known as drawing-in and may be performed either manually or mechanically, or second, by attaching the new threads to threads which are already in the healds and reed and then by drawing them forward they are passed through the healds and reed. This operation when performed manually is known as twisting, and when mechanically done is known as tying-in.

Weft yarn, which is to be woven into grey cloth, does not, as a rule, require much, if any, preparation before use in the loom. The yarn is spun into a cop or on a bobbin which can be used directly in the loom shuttle. It is a common practice, however, to keep the weft for a time in a moist atmosphere to improve its weaving qualities. Recently the practice of rewinding the weft has become very much in vogue, the object of this process being to remove weak places and to wind the weft into a more compact form, thus increasing the holding capacity of the shuttle by 2 to 2½ times, and by this means improving the quality of cloth and productiveness of the loom and greatly decreasing the waste made during weaving.

If either the warp or the weft yarns have to be dyed before weaving, they may be first reeled into hanks, which are dyed and then rewound on warpers bobbins in the case of warp, and on pirns or tubes for weft. Weft yarn is often dyed in the form of the cop spun on the spinning machine, and warp yarns are frequently made up in the form of a ball warp, consisting of a long chain or untwisted rope of the yarn, in which state it undergoes the dyeing and sizing processes before being wound on the loom beam. Yarn for export is generally reeled into hanks which are then compressed into suitably sized bundles. Much yarn is made into a suitable form for lace manufacture and into sewing thread, knitting and crotchet cotton, &c. The yarns used are generally of good quality, and are always folded or doubled, consisting of several single yarns twisted together to form one thread. Such yarn is frequently "gassed," *i.e.*, singed by gas or electricity.

Weaving.

The process of weaving consists of interlacing the warp and weft in some predetermined manner to form cloth. The fabrics produced in the loom are extremely varied, both in weight and in general character, from the finest muslin fabrics to heavy woollen rugs and blankets and driving belt textures, and from plain textures to highly decorated fabrics.

In the manufacture of the various textures which are the product of the loom a great deal of care has to be taken in the selection of the right kind of materials and their proper proportions to produce the desired type of fabric; and when a fabric has to be ornamented, this should be applied in such a manner as not to injure the texture in any way.

Bleaching, Dyeing, Printing and Finishing.

Cloth, when woven, has usually to be "finished" in one way or another, and a great deal has to be bleached, dyed or printed in addition. Bleaching is the process used for removing impurities and various colouring matters found in cotton, so as to leave the cloth white. Many different methods are used for bleaching, but the following is typical. The cloth is wetted out and impregnated with milk of lime; it is then boiled for six or eight hours, then washed and treated with acid to remove the lime; a second boiling with soda then takes place, after which the cloth is washed and treated with bleaching powder, followed by washing, souring with acid and final washing. Electric bleaching is used to some extent, electricity being used in the preparation of a hypochloride, used instead of bleaching powder. Cloth which is to be printed is always singed, in which process the projecting fibres known as "nap" are burnt off. This is done in some cases by passing the cloth over a red hot copper plate, or a gas flame singeing arrangement may be used. Cloth is "finished" in many different ways, but generally this process consists of calendering or mangling the cloth in one way or another to improve its appearance.

After the foregoing brief description of the processes involved in manufacturing yarn into cloth, the machines used and the problems confronting the textile engineer in the designing of these machines can be appreciated.

Spinning Machinery.

Spinning machines, with one or two exceptions, work under practically steady load and continuously, and are therefore, in general, more suited to group driving than to individual driving.

Bale Breaking, Opening and Scutching.

The bale-breaking machine acts on the cotton through the medium of two or four pairs of coarsely toothed rollers, between which the pieces of cotton taken from the bale are passed. Each pair of rollers moves at a greater surface speed than the preceding pair, and in this way the lumps of cotton are pulled out into a loose condition. During the process much sand and dirt is shaken out, and provision has to be made for its removal. The material is fed into the machine by means of a travelling lattice or endless chain of wooden laths, on which the cotton is placed. These travelling lattices are largely used in the earlier stages of spinning, whilst the cotton is in a loose state, for conveying the material from machine to machine with a minimum of handling. Air currents are also largely made use of to move the cotton both in the machines themselves and from room to room. From the bale breaker the cotton passes usually by lattice conveyors, to the mixing bins, whence it is taken by air currents through dust tubes to the "blowing" room, where the opening machines are placed.

Many different types of opening machines are used, but in the majority the cotton is fed into a chamber, where it is acted on by the blades of a revolving beater cylinder. This beating action opens the cotton and shakes out much dust, &c., which passes through grids formed in the casing of the beater chamber. An air current, induced by a fan, helps to carry the cotton from the beater chamber to a pair of collecting cages. The cotton is deposited in the form of a sheet on the perforated surfaces of these cages by the action of the air current, which passes through the perforation to the interior of the cages, which are in communication with the fan chamber. The cages are cylindrical drums, and as they are rotated the sheet of cotton formed on their surfaces is fed to a pair of calender rollers, which compress it and pass it forward to be wound on a round bar or tube, and so formed into a lap. Whilst passing under the action of the air current from the beater to the cages the material travels over the bars of a grid, which helps in the cleaning process.

The opening and cleaning process is now continued in the scutching machine. A sheet of cotton, composed of three or four thicknesses of opener lap, and formed by unwinding three or four laps simultaneously, is fed by means of a pair of feed rollers, or similar arrangements, into the scutcher beater chamber, and the end of the sheet is presented to the action of the beater blades. The beater consists of two or three blades approximately rectangular in section, carried at the extremities of arms mounted on the beater shaft. A two-bladed beater is about 14 in. in diameter across the blades, and revolves at about 1,400 revs. per min. The rapidly moving blades strike the end of the sheet of cotton presented to them and detach a certain amount of the material, which is carried round the chamber, the bottom of which is made of grid bars to allow dirt to fall out. After passing through the beater chamber the cotton travels as in the opener to dust cages, after which it is again formed into a lap. At the end of scutching the material ought to be nearly clean, so that the next machine, the carding engine, has only to remove short fibres, motes and small entanglements known as nap.

Great care must be taken, both in opening and scutching machines, with the construction and setting of the beaters, so that the cotton is properly treated without being cut or crushed. The length of lap produced is kept uniform by an automatic stop motion, which stops the machine when the required length has been delivered. The weight and thickness of the lap are kept as regular as possible, and this is usually done by automatically varying the speed of the feeding roller according to the thickness of cotton passing under it; if the thickness for any reason increases, the speed of the roller is reduced, and *vice versa*. The arrangements for the necessary air currents both in the machines themselves and between the machines and the outside air, need careful designing and attention.

Carding.

The chief organ of the carding engine is a cylinder about 40 in. diameter and 40 in. wide, whose surface is entirely covered with fine wire teeth set in a cloth foundation or fillet. These teeth, of which there are about 500 per sq. inch, project about $\frac{3}{8}$ in. from the cloth foundation and are slightly inclined forward for about three-quarters of their length. The teeth are kept sharp by means of a grinding roller, which is applied periodically. The lap formed on the scutcher is fed slowly into the machine, and a "licker in" roller, about 9 in. diameter, running at about 350 revs. per min., carries the material to the teeth on the cylinder, which rotates at about 160 revs. per min. As the fibres are carried round by the cylinder wire the carding is done by a similar set of wire teeth mounted on bars termed "flats," which extend across the face of the cylinder, and are so disposed that the wire teeth on them very nearly touch those on the cylinder. These "flats" are formed into an endless chain and are slowly withdrawn from action for cleaning purposes. The teeth on these flats are so set that as the fibres are carried past by the rapidly moving cylinder teeth, short fibres, motes, &c., are deposited on the flats, which are practically stationary. The fibres, after passing the flats are stripped from the cylinder at a point about diametrically opposite the feeding point by a roller also covered with wire, termed the "doffer," about 24 in. diameter, and running at about 15 revs. per min. From the doffer the fibres are removed in the form of a web by a rapidly oscillating stripping comb, and this web is collected and passed through a trumpet-shaped orifice, from which it emerges and is coiled, as "sliver" into a can.

The clothing of the various surfaces with wire requires considerable care, and variation must be made to suit the kind of cotton that the card is to operate on. Proper provision must also be made for setting the various organs relatively to each other, and for taking up wear at the cylinder and roller bearings. The wire teeth, especially on the flats and cylinder, require frequent grinding, and the necessary driving gear for the grinding rollers must be provided. The flats are cleaned or stripped in turn during working, but it is also necessary to strip the cylinder and doffer once or twice a day, since a considerable quantity of fluff and dust collect amongst the wires on their surfaces. This stripping is generally done by a revolving wire brush. The various rollers must be carefully balanced and careful designing is necessary to prevent detrimental air currents from being set up within the cylinder casing. The starting load on a carding engine is a heavy one, due to the heavy cylinder, and ample driving power must be provided.

Drawing.

The drawing frame is a simple machine, but its function is an important one. The machine consists essentially of four pairs of rollers, each pair rotating at a higher speed than the preceding one. Six or eight slivers from the carding engine are "doubled" or fed side by side to the first pair of rollers, and as the material passes from one pair of rollers to the next it is drawn out and the fibres arranged parallel to each other. The bottom rollers are made of metal and are usually fluted longitudinally; the top rollers are of metal covered with woollen cloth and a leather sheath. These rollers must be made with great care, and the distance between each pair must be arranged to suit the length of fibres and the kind of sliver, the distance being usually slightly greater than the length of the fibres. After leaving the drawing rollers the sliver passes through a trumpet-shaped guide to a pair of calender rollers, which deliver it to a coiler head, by means of which it is again coiled in a sliver can. Provision must be made for stopping the machine when any one of the slivers being fed into the machine breaks, or should the drawn sliver break between the rollers and the coiler, or should the sliver can become too full from inattention. The rollers should also be provided with cleansing arrangements to collect the "fly," composed of short fibres, thrown off during drawing, and which, unless systematically removed, form "slubs" which get into the sliver and eventually form thick, soft places in the yarn.

Slubbing and Roving.

After leaving the drawing frames the material is passed successively through the slubbing, the intermediate, and the roving frames, and in each the drawing out process is continued. The three machines are similar in construtjon and action, differing only in the size and strength of the parts and in speed to suit the gradual reduction in weight of the material treated. Briefly, each machine consists of a set of drawing rollers for attenuating the material, of the mechanism necessary to impart a small amount of twist to it, and the winding mechanism to wind the product on a bobbin.

The drawing rollers are similar to those used in the drawing frame. On leaving these rollers the material passes to the flyer, mounted on and rotating with a spindle driven at a constant speed. Passing first through a hole in the centre and the top of the flyer the material then passes down one of the arms and thence on to the bobbin, which is mounted loosely on the spindle, and driven separately. Every revolution made by the spindle imparts one twist to the "roving," and by suitably arranging the length delivered by the drawing rollers to the speed of the spindles, any required number of turns per inch can be inserted. The roving is laid in parallel layers on the bobbin by causing the latter to rise and fall, and, by reducing the travel of the bobbin after each layer has been wound, the ends of the bobbin are given a conical shape. The rate of winding is regulated by the difference between the speeds of bobbin and spindle, and generally in cotton spinning the speed of the bobbin exceeds the speed of the spindle. As the bobbin increases in diameter its speed must be reduced, which is usually effected by driving the bobbin by means of a pair of cone pulleys, through the medium of a differential motion, which permits of the speed variation given by the cones applying only to the difference in speed between bobbin and spindle, and enables the same cones to be used for varying the speed of the lifter rail which lifts and lowers the bobbins; the speed of this rail must also be reduced as the bobbin fills, in order to keep the pitch of the coils constant.

Spinning.

The spinning of the roving into yarns is carried out either on the spinning mule or on the ring frame; the former treats the material intermittently in stretches of about 64 in., first drawing and twisting it, then winding it; in the latter the processes are continuous and simultaneous. In the mule the roving is first drawn by drawing rollers, and on leaving these it passes to the spindle, whose rotation imparts twist to the yarn, and on which the yarn, after being twisted, is wound in the form of a cop. The spindles are arranged nearly vertically on a carriage, which is caused to recede slowly and at uniform speed from the drawing rollers through a distance of about 64 in. During the outward movement of the carriage the rollers are delivering cotton to the spindles, which are rotated at a speed of about 8,000 revs. per min., and impart the necessary twist to the yarn. When the carriage has reached the outward limit of its travel the rollers and spindles stop. Before the carriage begins its inward run the spindles are rotated several times in the reverse direction to unwind a few coils of yarn, which have been wound during twisting between the spindle point and the cop. The carriage is then drawn in at a much faster rate than during the outward movement, and during the inward run the stretch or length of spun yarn is wound on the cop, the spindles being rotated at a varying speed to suit the varying diameter of the cop. The process is then repeated. Although apparently a simple process, the mechanism required to carry it out satisfactorily is very complicated, owing to the intermittent character of the movements and the delicate nature of the material being treated. The driving effort required varies greatly throughout the cycle of operation, the power rising rapidly to its maximum during the starting up of the carriage on its outward run. (Fig. 2.)

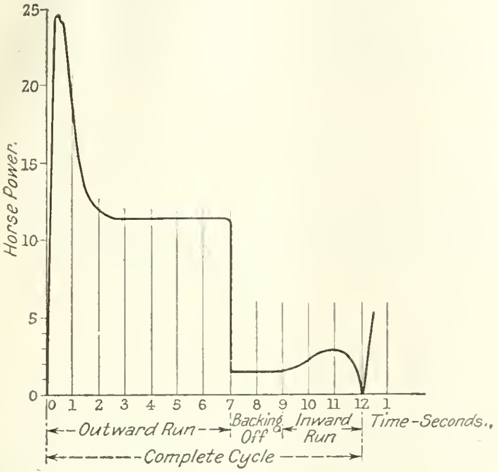


Fig. 2.—Approximate Variation in Power Required to Drive Spinning Mule.

In the ring spinning frame (Fig. 3) the roving is passed between drawing rollers, which complete the drawing out of the material. On leaving the rollers the cotton passes through a guide eye fixed a short distance above the top of the spindle; then it passed through the traveller, a small C shaped metal eye, which is sprung into position on the flange of the ring round which it is free to travel. On leaving the traveller the yarn passes direct to the bobbin on which it is wound; the bobbin is slipped tightly on to the spindle, and spindle and bobbin rotate at the same speed. The bobbin rotates at a speed of about 10,000 revs. per min., and draws the traveller round the ring at a speed nearly as high, the traveller lagging behind the bobbin a sufficient number of revolutions to allow the bobbin to wind on a length equal to the roller delivery. The traveller regulates the tension, and must be changed if the weight or "count" of the yarn is changed. The ring rail is made to rise and fall continuously through a distance equal to the depth of the "chase" or inclined part of the bobbin, and the lowest point reached by the rail is made slightly higher after each traverse. With a constant speed of spindles, such as is generally used, the tension of the yarn is continually varying, being much greater when the ring rail is at the top of its traverse, guiding the yarn on to the smallest bobbin diameter, than it is when the rail is in its bottom position with the yarn passing on to the largest bobbin diameter. This is due to the fact that the pull exerted on the traveller by the yarn becomes more nearly radial, and consequently must be greater, the smaller the diameter on which the winding is taking place.

By a suitable reduction in speed when winding on the smaller diameter, or an increase in speed when winding on the larger diameter, the tension can be kept uniform. This variable speed spinning is being used to an increasing extent, the machines being individually driven by variable-speed motors, the speed variation being effected automatically according to the height of the ring rail. The speed should be slow, and approximately uniform, at the beginning of a set of bobbins, say about 9,000 revolutions per minute; it should then gradually increase, and during the greater part of the building up of the bobbin should vary from about 10,000 revolutions with the ring rail at the top, to about 12,000 with the ring rail at the bottom of its traverse; finally, the speed should again be somewhat reduced towards the completion of the bobbin.

Machinery Preparatory to Weaving.

Preparatory machines, as a rule, are simple in construction and action. They vary very considerably in detail, both on account of the different ways in which yarn has to be prepared, and because considerable differences of opinion exist among machine makers and users as to the best type of machine for carrying out any of the operations. In winding machines the tension on the yarn should be kept as nearly regular as possible, with as high a winding speed as is consistent with good winding. This usually entails a variation in the rate of revolution of the bobbin or pirn, as its diameter changes, although in many cases constant speed is used and the tension maintained constant by some tensioning device; the resulting simplification of the machine is obtained at the expense of production, since the average winding speed is much lower than the maximum. Warping machines, also, must wind the yarn on to the loom beam at uniform tension, so that all the warp threads can be maintained at the proper tension during weaving. The doubling or folding of yarns is done either on a ring doubler (very similar in general principle to a ring spinning frame) or on a "twiner" mule, similar to the spinning mule. Care must be taken when folding yarns to ensure equality of tension on the threads which are being twisted together; and, in the case of ring doubling, this usually necessitates a preliminary winding, in which the single threads are wound side by side without twist on a flanged bobbin.

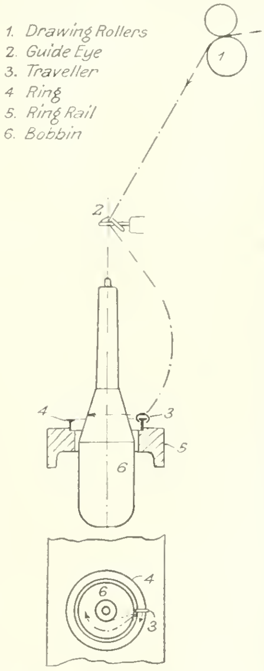


Fig. 3. Ring Spinning.

Weaving Machinery.

Cloth is woven on a loom, usually power driven, and although looms vary very much in detail and complication, according to the kind of cloth they produce, certain essential parts are common to all. Shedding is the term used to define the operation of separating the warp threads into two lines, which must be done before the insertion of each thread or " pick " of weft. In the simplest form of shedding motion (Fig. 4) the warp threads are drawn as already described, through the eyes of the healds, which are fixed to two or more lath frameworks, known as " shafts," so that when such a shaft is lifted or lowered it carries up or down with it all the warp threads drawn through the healds on that shaft. By lifting one or more of these shafts and lowering the remainder approximately an equal distance, the warp shed is formed. Shedding motions vary from the simple type described, in which, with two shafts, every alternate warp thread must be lifted or lowered at the same time, to the Jacquard shedding motion, in which any warp thread can be lifted or lowered independently of the others.

Picking is the operation of sending the shuttle, carrying the weft thread between the lines of warp formed by the shedding motion. The shuttle is supported during its passage through the warp shed, by a wooden raceboard carried by the " slay," and by the reed. Otherwise the shuttle is uncontrolled during its passage. When clear of the shed the shuttle is brought to rest in a shuttle box, one of which is provided at each end of the slay. The picking is usually done mechanically by means of a cam acting through levers on a buffalo hide picker which pushes the shuttle out of the shuttle box. The picking motion is one of the least satisfactory parts of a loom, but it has to perform a difficult task. The time available for the passage of the shuttle is so small that the average speed of the shuttle must be from 40 to 50 ft. per second; the weight of the shuttle, as the weft is withdrawn, is constantly changing; and the slay and reed which guide the shuttle swing backwards and forwards as the latter moves across.

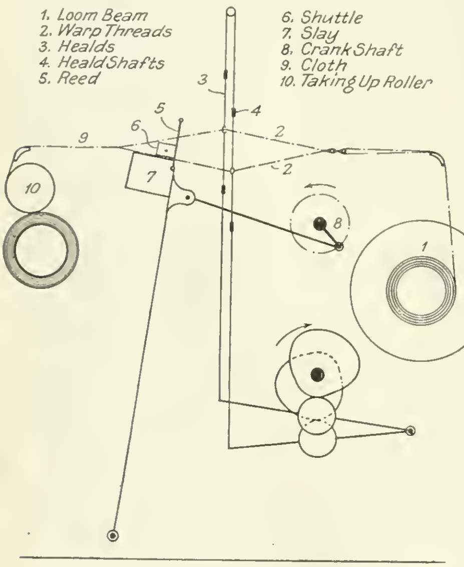


Fig. 4.—Power Loom Mechanism.

After it has been carried across by the shuttle the weft requires " beating up " which is done by the reed already mentioned. Movement is given to the reed, and to the slay which carries it by means of cranks, acting through connecting arms. The crank shaft is usually the driving shaft of the loom.

In addition to the three primary motions described—shedding, picking and beating-up—a number of subsidiary motions are required. The cloth, as it is woven, must be drawn forward or " taken up " : at the same time the warp requires " letting off " from the warp beam. A weft stop motion is almost invariably fitted to stop the loom should the weft break, or the supply in the shuttle give out. Although by no means so universally used as the weft stop motion, a warp stop motion to stop the loom on the failure of a warp thread, is desirable. The weft stop motions in use are simple and reliable. Warp stop motions are usually considered to be too complicated to justify their adoption; they sometimes act mechanically, whilst in others the breakage of a warp thread permits an electric circuit to be closed and the loom to be stopped. A warp stop motion is an essential part of an automatic loom. A stop motion must also be applied to stop the loom should the shuttle for any reason, fail to get through the warp shed in the time allowed. These motions are of two main types, and neither is quite satisfactory. In the fast reed stop motion, if the shuttle fails to reach its destination the moving parts are stopped by suddenly arresting the slay. Although a brake is applied simultaneously, the sudden stoppage throws a great stress on many of the loom parts. In the loose reed motion the reed is kept in position by springs, and if the shuttle is trapped the pressure thrown on the reed overcomes the holding springs and pushes the reed back far enough to prevent breakage of the warp threads. This form of reed is not sufficiently rigid to beat up the weft in many types of cloth.

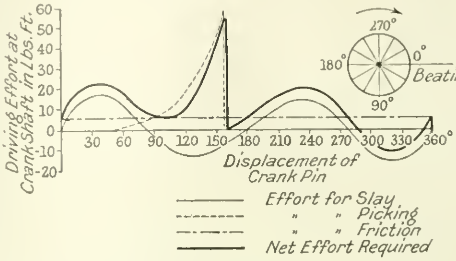


Fig. 5. Approximate Variation in Power Required to Drive Loom.

When different colours or kinds of weft have to be inserted a box motion, to enable two or more shuttles, each with its own kind of weft, to be used, must be fitted to the loom. Many fabrics also require for their successful or economic production special looms or special mechanism added to the parts described.

The weft supply in the shuttle is generally replenished by hand, which necessitates stopping the loom for a few seconds at about five minute intervals; in addition casual stoppages for the repair of broken warp, weft, &c., are more or less frequent, depending on the quality of the yarns and other conditions. Automatic weft supply is used in some cases, the most successful loom of this type being the Northrop.

The speed of looms varies with the width and the kind of cloth being woven. A loom weaving plain calico 36 in. wide, runs at about 210 revs. or picks per minute. The driving effort required by a loom throughout the revolution of the driving shaft is constantly varying, chiefly on account of the varying effort required to move the slay and the intermittent effort required to accelerate the picking motion and shuttle. This gives rise to considerable cyclical speed variation, which is undesirable, and to much vibration. (*See* Fig. 5.)

Even more important than regular speed throughout the cycle is regular speed from minute to minute; for if the revolutions per minute vary, not only is production lost, but the shuttle will probably fail to get home in the shuttle box when the speed is below normal.

The characteristics of a good drive are a high starting torque and regular speed, the drive being sufficiently powerful to prevent large cyclical speed variation. A good starting torque is required to get up speed quickly. The loom is started with the crank approximately at the top centre position and picking takes place about half a revolution later, by which time if possible full speed should be attained. The loom is thus a very suitable machine for individual driving, and that system is now used to a considerable extent.

The noise made by looms is at present attracting the attention of manufacturers, and if this could be materially reduced it is probable that the weaving shed would be more attractive to young workers than it is at present.

Bleaching, Dyeing and Finishing Machinery.

The machines used in the finishing processes are usually of simple construction and action; they generally run somewhat intermittently, and so lend themselves to individual driving.

Ventilating, Humidifying, &c.

The ventilating, heating and lighting of textile factories present some problems peculiar to the industry. Considerable quantities of dust have to be removed, especially during the earlier spinning processes. Again, cotton cannot be worked satisfactorily, especially in the spinning process, in a dry atmosphere, and the atmosphere in the room is generally humidified by water vapour, either introduced directly into the rooms by sprays or mixed with the air in conjunction with the ventilating and heating arrangements.

APPENDIX.

Approximate Power Required by Various Machines.

Opening Machine	4-5 h.p.
Scutching Machine	6 h.p.
Carding Engine	¾ h.p.
Drawing Frame, per delivery	¼ h.p.
Slubbing Frame, 68 spindles	1⅔ h.p.
Intermediate Frame, 74 spindles	1⅓ h.p.
Roving Frame, 160 spindles	2 h.p.
Spinning Mule, 230 spindles	1 h.p.
Ring Spinning Frame, 120 spindles	1 h.p.
Plain Power Loom, 36 in. wide, 210 picks per min.	½ h.p

The Cotton Industry of the United States.

An Interesting Account of the Present State of Affairs.

By FRANK NASMITH.

(Editor of the "Textile Recorder")

To anyone intimately connected with the Lancashire cotton industry—in which the bulk of the mills are situated within a 30-mile radius of Manchester—the most striking feature of the cotton industry of the United States is the isolation of some of the mills and the vast distances which separate them. Further, in the great majority of cases, no matter where the mill is located, the selling house for its products is in New York, and one will find a mill or set of mills located in Georgia, some 1,000 miles from New York, disposing of its or their whole product through a commission house in that city. The next most striking feature, is the vast size of the plants, a matter that will be dealt with later.

The Development of the Industry in the South.

There are many distinct differences between the mills of the Northern and Southern States, differences not only of appearance, lay-out or product, but also of labour, staff personnel and an indefinable atmosphere which one cannot put into so many words, but which appears to be a distinct characteristic of the South. The Northern mills are more akin to our own, and it certainly appears that there is as much difference between the North and South as there is between England and France, as far as the mill industry is concerned. The Southern States are comparatively new competitors in the cotton industry of the world. After the Civil War, it appeared as if the South was not likely again to compete with the North, but there was a virility amongst the young men of the South that has effected remarkable results, and to-day, one looks to that part of the United States for the greatest progress in regard to textile matters. Certainly, the results secured have been enormous.

The charts (Figs. 1 to 6) shown will demonstrate the growth of the South very clearly and it will be agreed that really remarkable progress has been made in a very short space of time. Taking a period of 10 years, it will be seen that

1909, Spindles in the South	10,500,000
1919, ,, ,,	15,000,000
10 years' increase	43 per cent.
Spindles in the World	150,000,000
,, ,, United States	33,000,000
,, ,, South	15,000,000
,, ,, South	10 per cent. of world total.
,, ,, South	45 per cent. of United States total.
20-year increase of spindles in Northern Mills	39 per cent.
,, ,, ,, Southern Mills	311 per cent.
15-year increase in value of production,	
Northern Mills	73 per cent.
,, ,, ,, Southern Mills	199 per cent.

In 1912-13, just prior to the war, the Northern mills consumed 2,597,000 bales of American cotton, the Southern mills 2,939,000 bales. In 1917-18 the amounts respectively were 2,946,000 and 1,129,000 bales. The figures given clearly show how rapidly the South is going ahead. The mills of the Southern States are largely located in the cotton belt itself. They are ideally situated for obtaining their supply of raw material. Damage by transport is not so great, and the raw material has to travel a comparatively short distance from the compress to the mill.

Labour Advantages in the South.

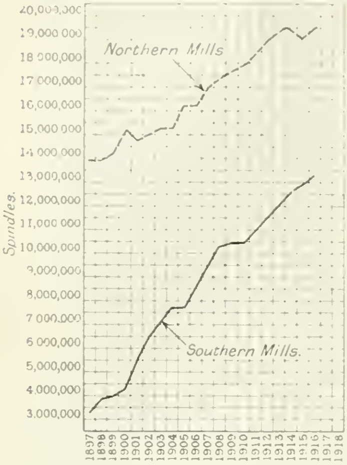
There is one factor which certainly favours the South, although it may not be apparent at first sight. It is the class of labour obtainable. In the New England States one finds a very mixed bag of operatives, and it is no uncommon sight in the mills to see notices posted in six or more languages. Italians, Roumanians, Lithuanians, and many other nationalities are represented in these Northern mills. The best class of operatives are those who have emigrated from Great Britain, or the French Canadians who have come down from Canada.

In the New England mills it is no uncommon thing for the nominal roll of a mill to change completely in three years. This is one great fact which should be remembered when one compares the Lancashire cotton industry with that of the United States. In Lancashire our operatives have a hereditary knowledge, an inherent cleverness which has come down to them through many generations. They do not migrate readily—particularly the men—and consequently they are infinitely better producers than the polyglot labour that is found in the New England mills. Incidentally, it is this low class labour that has forced the United States cotton industry to go in so largely for automatic machinery.

In the Southern States one does not find this mixture prevailing. The labour has been largely recruited from the country and, in the writer's opinion, it is of a superior class, more competent when fully trained, and certainly more stable than that found in New England. Moreover, it is non-union. In the North one finds unions. Not perhaps so well organised as our unions, and treating individually with the several mills whose proprietors are not banded together as ours are. As one proceeds South, these unions become of less and less importance, and when the Mason-Dixon line is crossed they are non-existent. In one mill centre alone—that of La Grange, Georgia—there are 7,000 operatives, not one of whom is a unionist, and there are only about three foreigners in the town. In fact, it is the proud boast of the inhabitants of Georgia that they are purer-blooded Anglo-Saxon than are the inhabitants of the British Isles.

Large Size of the Mills a Distinctive Feature.

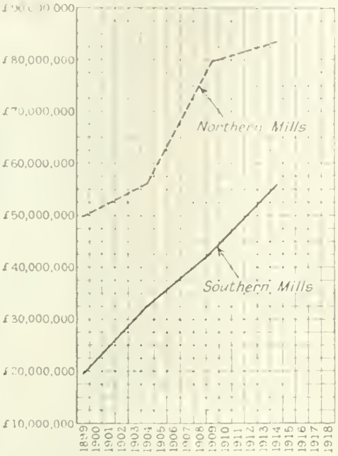
One particularly notable feature of the United States cotton industry is the vast size of the mills and their completeness. In this country one finds spinning mills, weaving sheds, bleaching, dyeing, printing or finishing plants all individual and owned by different companies. Yarn may be spun in Oldham, sent to Burnley to be woven, the fabric sent from there to Accrington or some other centre to be bleached, dyed, printed or finished, and the final product sent to a Manchester warehouse for sale. In the United States mills, particularly the large plants located in New England, all the processes except disposal are carried out in one plant. These large concerns will often contain 200,000 spindles, 1,000 to 5,000 looms, and a complete complement of auxiliary plant for carrying out all the processes necessary to produce the finished fabric. To the Lancashire man, some of these plants appeared to be unwieldy and certainly in specific organisation and efficiency they did not compare favourably with those in this country. This statement must not be misunderstood. The product of some of these plants was exceptionally good



Increase in Spindles for 20 Years.

Increase Northern Mills.
From 13,900,000 Spindles to 19,424,000 Spindles. Increase per cent., 39.

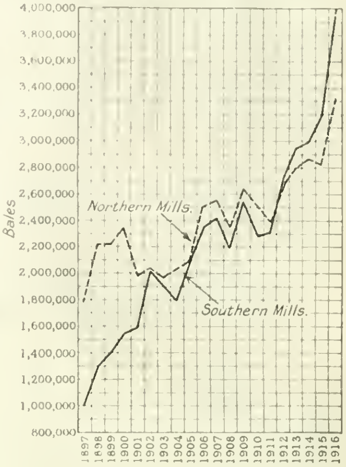
Increase Southern Mills.
From 3,250,000 Spindles to 13,382,000 Spindles. Increase per cent., 311.



Increase in Value of Products for 15 Years.

Increase Northern Mills.
From £48,167,000 to £83,138,200. Increase per cent., 73.

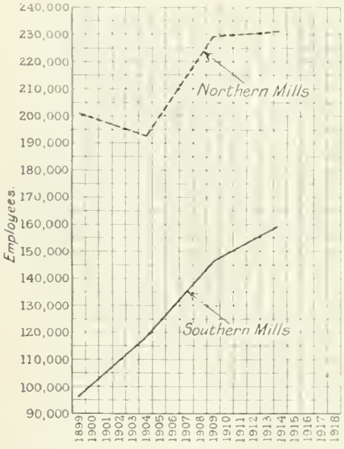
Increase Southern Mills.
From £18,739,000 to £56,006,400. Increase per cent., 199.



Cotton Consumption for 20 Years.

Increase Northern Mills.
From 1,793,000 Bales to 3,301,000 Bales. Increase per cent., 85.

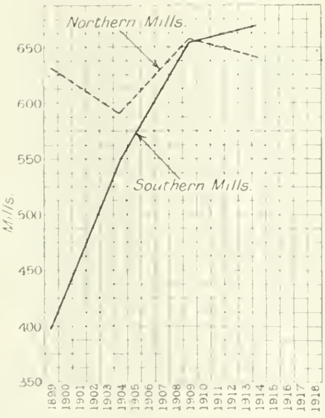
Increase Southern Mills.
From 999,000 Bales to 3,997,000 Bales. Increase per cent., 298.



Increase in Employees for 15 Years.

Increase Northern Mills.
From 201,123 Employees to 231,391 Employees. Increase per cent., 15.

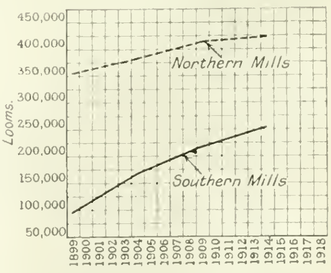
Increase Southern Mills.
From 96,138 Employees to 159,302 Employees. Increase per cent., 66.



Increase in Mills for 15 Years.

Increase Northern Mills.
From 633 Mills to 642 Mills. Increase per cent., 1.

Increase Southern Mills.
From 395 Mills to 667 Mills. Increase per cent., 69.



Increase in Looms for 15 Years.

Increase Northern Mills.
From 354,981 Looms to 421,641 Looms. Increase per cent., 19.

Increase Southern Mills.
From 95,701 Looms to 251,113 Looms. Increase per cent., 162.

Figs. 1 to 6.—Charts Showing Developments in the U.S. Textile Industry.

and the general organisation was almost perfect, but it was in the actual operations that one detected losses which may have been due to the vastness of the plant or to the class of operatives employed. For example, waste produced in looms was greater than in this country and loom efficiency was much lower. In one mill there is 203,000 ring spindles on one floor, 5,000 looms on another, besides a silk throwing and silk and artificial silk winding department as part of the mill.

Spinning machinery is run at the same speed as that in this country, but weaving machinery runs much slower. Automatic looms are largely employed and wherever possible automatic machinery is utilised to the fullest possible extent. Weavers operate from eight to twelve—sometimes more—plain looms. Generally speaking, the stock of cotton employed—that is the quality of the fibre—is extremely good. More twists or turns per inch are inserted and spinners in this country would spin a higher range of counts with the same material.

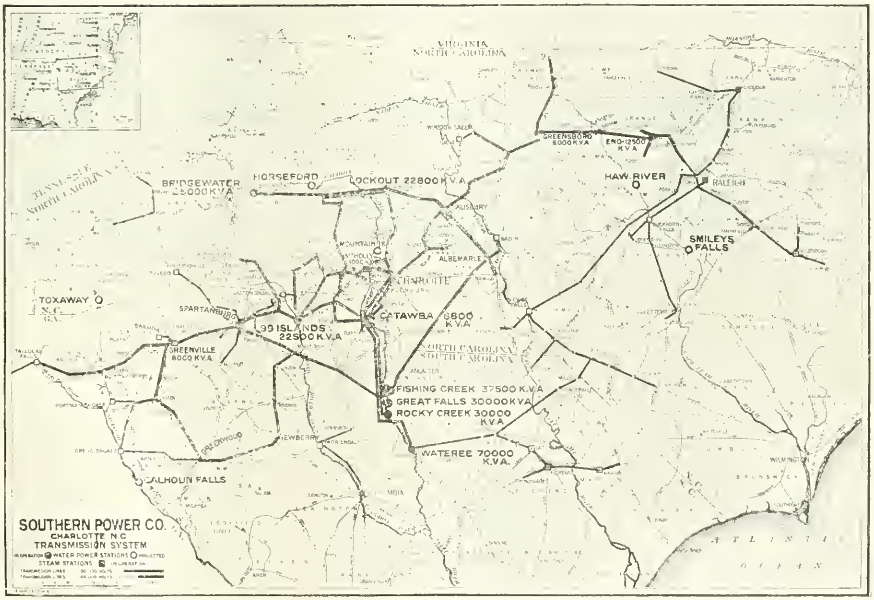


Fig. 7.—Map of the Southern Power Company's Area.

Differences Between English and American Practice.

The American mills used to be noted for repetition work. The weaving sheds would turn out one quality of cloth having the same weaving particulars—width, ends and picks, counts of yarns, &c.—year after year, and many of them continue the practice. But many mills are now producing quite a variety of fabrics, and particularly in comparatively fine fancy shirtings one can find quite a number of varieties in the same mill. In one mill, 100 different varieties of fabrics were to be found. Curious differences present themselves in regard to Factory Laws. In some States women are not allowed to work after 6 o'clock, in others a 60-hour week is possible; down in the South one noticed that dangerous parts of many machines were rarely fenced. Dust collecting is evidently not essential, as it is in the card-rooms of the Lancashire mills, and the writer saw clouds of dust, short fibre motes, &c., thrown up by the stripping brush applied to a card in a very up-to-date mill in the North. Certainly the systems of ventilation adopted are exceptionally good, and in the majority of mills the air is changed very frequently in the various rooms. One feature that immediately strikes the visitor in any American textile mills is the prodigal use of, or waste of, space. Apparently space is no object, and the alleys between the machines are very much wider than those provided in Lancashire mills. Another feature also very noticeable is the very free provision of drinking fountains of an extremely hygienic type. Water cooled to about 46° F. is provided for these fountains, and at one mill a special automatic plant was inspected, comprising essentially a hermetically sealed drum, containing some form of gas, rotating within a reservoir or tank of water. Should the temperature of the water fall below 46° F. the drum stopped revolving; should it rise above 50° F. the drum started up again.

The dress of the female operatives, especially in the winding rooms, strikes one favourably. They are better dressed than are our operatives and favour silk stockings with high-heeled shoes, transparent blouses and extremely fascinating underwear. Provision of lockers in which they can keep their outdoor clothes is, perhaps, conducive to a smart appearance on leaving the mill.

With regard to cloth finishing plants, many of the units are larger than those in this country. In some cases 1,000,000 yards of cloth are turned out in a single day. Almost the entire output is absorbed by the home market and consequently large bulk orders are the rule and not the exception, so that by having much longer runs to a style or pattern than is customary here, it is easier to get a large output. Generally speaking, the works are more modern, more spacious and more economically laid out than is the case in this country, and this feature, together with the wealth of machinery and labour-saving devices that is the rule and not the exception, are the most striking features which impress the visitor.

In some of the spinning mills only half the necessary machinery required to provide material for the subsequent machinery is employed, and in consequence, night-shifts are run. These shifts are composed of men, and in one particular instance 680 cards were made to accomplish the work of 1,514 cards.

Some Interesting Operating Features.

Electric driving is largely employed in the United States mills, and the individual drive is the generally adopted method. In the New England mills a large proportion of the power is generated at the mill itself, but in the South, thanks to a very wonderful hydro-electrical development, the majority of the mills purchase their power from outside sources. In regard to power generation, the use of oil as fuel is growing. It is an extremely simple turn-over from a coal fired boiler to one using oil, and at one mill visited the change had been very expeditiously made. The existing boilers were used, the grates being removed and stored against future use, when it would be an easy matter to re-install them. The plant was at the Lorraine Manufacturing Company's mill, Pawtucket, Rhode Island. The boilers were of the vertical type, and although the mill had an old contract for oil, it can be proved that even on the present price of oil, as compared with coal, a saving will be effected. The recent strike in the American coal trade will, no doubt, result in a further increase in coal prices, in which case the oil user is going to have a still further advantage.

Fig. 8.—Ginneries, etc., at Scott, Mississippi. The Plantation of the Fine Cotton Spinners.

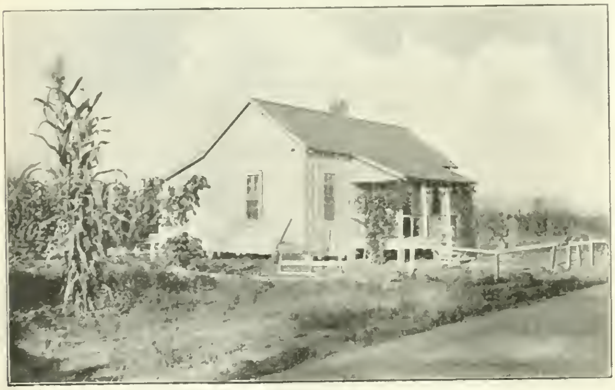


Fig. 9.—Cotton Picker's House. Plantation of the Fine Cotton Spinners, Ltd., at Scott, Mississippi.

The oil pressure was 160 lb., and one man looked after eight boilers, two of which were idle at the time of inspection. Special automatic regulating devices are being supplied to the boilers, which reduce the oil supply if the pressure exceeds a certain limit, and increases it if the pressure falls below the limit set.

Fig. 10.—Raw Cotton going to the Gin. Greenville, S. Carolina.

The following table gives the comparative costs of oil and coal at this mill:

(1) Cost based on coal and labour figures of August, 1915.

(*a*) Coal mixture of 87·6 per cent. of New River and 12·4 per cent. of buckwheat. Heating value of mixture 13,593 B.Th.U. per lb. and boiler efficiency 65 per cent. Price $4·123 per ton of 2,200 lb.

(*b*) Coal for banking fires taken as 3,000 lb. of New River coal per boiler per week for 25 weeks.

(*c*) Fuel oil at $1·10 per barrel of 42 gallons; 18,260 B.Th.U. per lb. and 8·005 lb. per gallon. Boiler efficiency 79 per cent.

(*d*) Labour per week as follows:—

	Coal.		*Oil.*
1 coal passer	$9·00	...	$00·00
1 day fireman...........	$13·50	...	$13·50
1 night fireman	$12·00	...	$12·00
Total per week ...	$34·50	...	$25·50

(*e*) Cost of handling ashes $3 per week. Total cost per 100,000 lb. of water evaporated from and at 212 F., assuming an evaporation of 2,000,000 lb. of water per week:

	Coal.		*Oil.*
Fuel	$20·582	...	$22·010
Banking fires	$00·379	...	......
Labour	$1·725	...	$1·225
Ash handling	$0·150	...	......
Total	$22·836	...	$23·235

Difference in favour of coal, 1·75 per cent.

(2) Cost based on coal and labour figures of June, 1916.

(*a*) Coal mixture having as average heating value of 13,978 B.Th.U. per lb., and boiler efficiency 65 per cent. Price of mixture $5·078 per ton of 2,240 lb. This price is based on New River at $4·75 on cars and buckwheat at $3·36 on cars.

(*b, c, e*) as above.

(*d*) Labour 15 per cent. higher than in August 1915. Total cost per 100,000 lb. of water evaporated from and at 212° F.:—

	Coal.		Oil.
Fuel	$24·212	...	$22·010
Banking fires	$00·426	...	......
Labour	$1·984	...	$1·409
Total	$26·772	...	$23·419

Difference in favour of oil, 12·52 per cent.

An increase of $0·10 per ton in the price of coal will change this difference by 1·5 per cent. It will be noted that the cost of coal is given at $4·123 a ton. Since the date of the test coal has risen to over $5 a ton—in fact, nearly to $6, so that, taking the difference as 1·3 per cent. for every $0·10 rise in the price of coal, the difference in favour of oil is now more marked than ever at this particular mill.

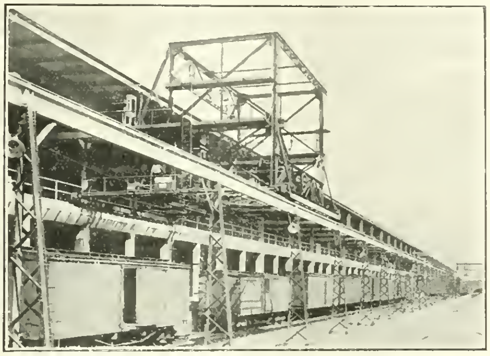


Fig. 11.—Transport Apparatus at Memphis.

The greatest hydro-electrical development in the United States radiates from Charlotte, North Carolina. It furnishes current over 2,000 miles of high tension transmission wires to more than 100 towns and cities, and drives the street electric railways in more than a dozen communities. Eighty per cent. of the power is, however, used to drive textile mills. A glance at the map given herewith (Fig. 7) will show the area covered. The Southern Power Company drives over 4,200,000 spindles in the 300 textile plants. It has 350,000 h.p. of hydro-electric generating plant, and 48,000 h.p. plant in emergency steam electric stations. The annual output of the company is equivalent to burning 1,000,000 tons of coal. In one mill visited a curious method of driving the card-room was noted. Below the floor of the card in a basement the driving shafts were carried. A motor arranged at one end of each shaft drove it and from pulleys on the shaft the driving belts led up through the floor to the pulleys of the carding engines.

Textiles and the Motor Car Industry.

Probably the most impressive and insistent sight in the United States to-day—if one excludes the wonderful electric sign night advertising in Broadway, New York—is the abundance of motor cars. The United States has roughly a population of 100,000,000, excluding Havana and the Philippines. In certain sections—New York and the districts surrounding up to Boston—Chicago and other large industrial centres, there is a motor car to every eight people. Throughout the United States it has been computed that there is a car to every 17 people, men, women and children. Taking a line on this, the necessity for the Ford Company to turn out 4,000 cars a day—their present rate of production—will be appreciated. Allowing a car to have only four tyres per year, the amount of tyre fabric or yarn necessary to manufacture the tyres required is over 110,000,000 lb. per year. This will account for 250,000 bales of cotton—which, for tyre yarns, must be of the best quality—cord tyres are manufactured in quantities and some mills are producing nothing but 23s. combed yarn from the beginning to the end of the year. In one set of three mills the output per week is 575,000 lb. of combed yarn. Now 80 per cent. of the world's clothing is made from cotton, and this great amount of material withdrawn for other purposes, taken in conjunction with other matters, will seriously affect this country as regards the future supply of raw material for those fabrics which Lancashire produces.

The American Cotton Crop.

It may be as well at this point to say something in regard to the American cotton crop. During the war the Southern planter for the first time planted foodstuffs which previously he had imported from the North-West Provinces. He is now determined to diversify his crops and the result is a shorter crop of cotton. Labour conditions have materially altered in the South, and the negro labour, which used to be so plentiful, has now migrated to the towns. Moreover, the wages of this class of labour have risen enormously. There is more work attached to the production of a cotton crop than there is in regard to wheat, maize, oats or other foodstuffs No mechanical cotton picker is available, and a great deal of labour has to be maintained throughout the year against the need of the picking season. Consequently the planter is more inclined to plant those crops which give him the least trouble, and the result is a threatened shortage of cotton. Many factors make up the danger to this country—the reduction in acreage, the greater takings of the American mills, particularly those located in the South, the increasing use of good staple cotton for tyre fabrics and the increasing ravages of the boll worm. It is a vital necessity that we should seek by every means in our power to increase the growth of cotton within our Empire and remove for all time the menace of shortage which threatens us. If the cotton industry left Lancashire, one-third of the population of the British Isles would have to emigrate or seek new jobs.

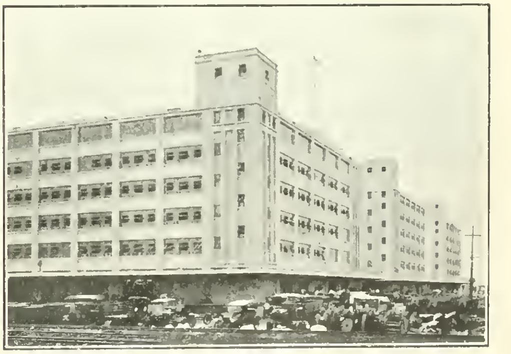


Fig. 12.—Cotton Warehouse, Memphis.

Welfare Work in U.S. Textile Mills.

A considerable amount of welfare work is undertaken by the textile mills of the United States. Elaborate measures are employed to render labour stable, for it is acknowledged that the cost of losing one operative and finding and starting up another averages $90. At one American mill, what may be termed an Industrial Relations Bureau has been instituted. Its operation was apparently simple, but its work was difficult and its results excellent for the mill. An extremely tactful and diplomatic head was installed in this Bureau. He was apparently young in years but old in guile. No operative was allowed to be engaged or discharged without passing through his hands. He got the mill requirements for labour each morning and carefully sifted the applicants endeavouring to allocate them to the best advantage. Should any operative wish to leave, he was not allowed to do so before interviewing the head of the Industrial Relations Bureau. And it was here that the said head got in his fine work. He gently but surely extracted from the operative his reasons for wanting to leave. It might be inharmonious home surroundings, a sick wife who did not fancy the locality, an overbearing superintendent or overlooker, or one of many other reasons. If there was the least possibility of smoothing over the difficulty it was done, and the results that have been accomplished have been really marvellous. Medical departments or hospitals are located at every mill, and nothing but praise is due to the excellent equipment of these hospitals. They are as perfect as it is possible to make them. The productive value of such hospitals cannot be overlooked. Before their institution the operatives would wander off to the doctor in the town or village, probably spending the morning away from the mill for a minor ailment. Now the operative is clocked off to go to the hospital—the time he is there is booked—and he is clocked on when he returns. The average time away from work is small, and, moreover, a number of operatives who would for a slight sickness refrain from attending the mill turn up to be treated and are persuaded, if the complaint is only slight, to carry on with their work. So the hospital also in this direction maintains the labour efficiency of the mill. The nurses are also available for district visiting, and in this way carry the interest of the mill in the welfare of the work-people right into the homes of the latter.

Housing and the Textile Industry.

Housing is just as difficult a problem in America as it is in this country, and in many centres the mill interests are building houses for their workpeople. The rental cost to them is low, running about $1 per room per month—most of the newer houses being provided with baths. In La Grange, Georgia, the interests of the workers appear to be the first consideration. Besides providing them with houses and a sufficiency of land to enable vegetable produce to be raised, free greenhouses are available, where intensive culture can be carried on and the results subsequently planted out in the respective gardens. Educative methods are adopted with the children to create in them a love for a pleasant home, and the result is really remarkable. One hardly sees a neglected garden, and the whole effect is most excellent. Then, situated in one of the most beautiful spots of La Grange is the Martha Washington home for female operatives, a boarding house with a distinct individuality and apparently an extremely pleasant place to live in. A men's hostel is also provided, swimming pools (the best disciplinary measure available is to deprive a youth of his bathing ticket), a very active Y.M.C.A. and recreative unions of all kinds. Free schools are provided in which each and every child sits in a position where the light comes over his or her left shoulder. The funds to build the churches have been provided in the following proportions: one-third from the stockholders in the mills, one-third from the community and the remaining third from the mills. It will be seen that the mills really provide out of profits two-thirds the sum required.

One final point remains, namely, insurance. In one mill visited—and we believe the practice extends to others—the employees are insured by the mill itself according to length of service.

Three months, but less than one year				$500
One year,	,,	,,	two years	$600
Two years,	,,	,,	three years	$700
Three years,	,,	,,	four years	$800
Four years,	,,	,,	five years	$900
Five years and over				$1,000

No medical examination is required for this insurance, which ceases upon termination of employment. This again is an inducement to the operatives to stay at one place.

Textile Mill Equipment—Its Advance and Systems.

By C. S. Ickringill.

Has electrical driving for textile mills come to stay? What is there about it which is going to prejudice steam or gas engine drives? Is there any likelihood of further developments in electrical driving, and what form will they take?

Probably these are the first questions which are asked by textile millowners when they are approached by the electrical engineer who is making a special study of the driving of textile mills. I think they are very wise and necessary questions, too, and open the conversation immediately. They call for very careful explanations, and a great number of points can be introduced into the explanation. At the same time the first of these questions takes the most answering, and in doing so you are almost bound to answer the second question. It is, therefore, better to my mind that the two should be grouped together, so let us make our first question, "Has electrical driving in textile mills come to stay, and why?" In answering this we can work on broader lines, and not encroach on a specific second question. In doing so one is bound to repeat part of what has so very often been said and written—but I feel that this will do very much more good to-day than ever it has done in the past.

Electric Driving Has Come to Stay.

I feel this system has undoubtedly come to stay. It has been introduced into not much above 1 per cent. of the total number of textile mills in this United Kingdom as yet, but in that 1 per cent. it has been found so beneficial that satisfaction with it is very widely spread. On the Continent of Europe the electric drive has grown more rapidly than in this country, it has been considered very much more seriously, it has been given a far greater trial, and the result is that I can say almost every mill to-day is having the electric drive installed, or is preparing for it in the very near future. In America we hear of very great developments in electrical drives. It is interesting, for instance, to note that the members of the English Delegation to the World Cotton Conference in America report that they found practically all the mills were electrically driven upon very efficient lines. Practically all forms or rather systems of "electric driving" had been tried and much experimental work had been carried out with the idea of improving the whole scheme, and trying to arrive at a standard type of driving for each process.

To go into these various systems would take up a very large amount of space, and would not be beneficial in a cramped form. It may be said here, however, that we do not need to go to America or the Continent of Europe to gain information on the systems of driving to adopt. In this country to my knowledge nearly every system of driving has been tried. As readers of The Electrician will be aware, for many years now there has been considerable interest taken in arguments put forward for group, small group and individual drives. It is not my idea to deal with these here, but I just want to say a few more words with regard to the feeling in England on this question of the electric drive.

Information on the Electric Drive Wanted.

Wherever you go, on Manchester Exchange, on Bradford Exchange, into the textile industrial districts of Lancashire, Yorkshire, Leicester, West of England, Scotland or Belfast, you find that the millowners thirst for information on the electrical drive as applied to textile mills. Every mill manager is longing to have it installed, overlookers are out for positions in the mills that are already electrically equipped, and the hands appreciate its advantages enormously.

Why should these people have these longings, and why should the drive be so appreciated? I say that these people have heard from their fellows of all that the electric drive will do for them. They have been told that it is a necessity for good business and pleasant working. Not only have they been told this, but it has been put to them in such a way that they can see what it means to them, and feel more really why they should have it themselves.

Now who can possibly explain the advantages better than the person who has the actual experience, and who is the man who has the best means of gaining this experience—why, it cannot be anybody but the mill manager, the man who has so many definite objects in view. Some of these objects are: economical running, cheap production, highest possible production, maintenance of quality, satisfactory assistants, good hands (plenty of them), and welfare of his workpeople. A man who has a record for securing these objects has gone a long way towards finding out the best form of driving and the most pleasant conditions under which to work. He therefore must have experienced the electric drive. It therefore appears that such points as these must have been insisted upon in the information given to his fellows, and this is why there is that great desire to get into a mill which is equipped with an electric driving installation. Two other points go to emphasise my statement on this point. They are these: Out of all the electrical installations I have heard of being installed, only in one case have I heard it was not satisfactory, and the largest textile businesses in the country are those who have most enthusiastically adopted it.

These are all points which make me feel that this form of driving has come to stay. But these are only based on the general appreciation. Let us go further and deeper into the subject, and see if there are not some real reasons of necessity for this drive, let us see if there are not some advantages in it which cannot be got in any other form to the same degree. If we can put arguments of this kind forward, then surely our case for the future lies in improvement, and not in introduction.

The Textile Engineers and the Electric Drive.

First of all, then, we will consider the engineer's points, then follow that up with what I will call the textile technical points.

Our first question will be that of power supply, and whether it ought to be privately generated, or taken from a supply company. This, to my mind, is not one about which there can be any argument. The factors which tend to make motor cars, the manufacture of cardboard boxes, buttons, and, if I may say so, Treasury notes, one of mass production, gives the decision on this point. The supply station, which generates power in bulk, ought to be able to supply at a more reasonable figure than it can be generated privately in comparatively small quantities.

There are, of course, other advantages in taking a supply from a power company. The number of boilers is reduced, and there is no anxiety about the transport for large quantities of coal. A man whose special duty it is to be in the engine room all the time the plant is running is not required. There is in normal times a collosal stand-by, and as much power at disposal at a second's notice as the plant is capable of demanding for working purposes.

There is also the satisfaction of knowing that you are only charged for the actual power used, and you have not to generate that which is not continuously required. As an electrical engineer, and one devoting his time to the driving of mills, and, further, one who is desirous from a plant point of view, to install generating plant as well as the running plant, I cannot help but feel it is to the millowner's advantage to take power from the supply company, and I feel that if that is not the case to-day, it will be so at a very early date. The demand for a supply from the present corporations is so great that it cannot be coped with at the present. This means larger generating units must be installed at once, and these units, to give satisfaction in the station and to the consumer, must be more economical than the present plant.

Is Power Saved by the Electric Drive?

The next point to be raised is: Can any power be saved if we introduced the electrical drive, and would this be materially to our advantage? To this anybody who has seen a mill of, say, 50 years' standing can answer yes, but we must not argue on just that type of mill, for during many years' experience of visiting mills I have seen some splendid steam plants and mechanical drives.

In the older types of mills, we have bevel gears, upright shafts, the extraordinary weighty shafting (*see* Fig. 1), all which takes an enormous proportion of the power. Of the tests I have carried out in such mills it has not been an uncommon occurrence to find 50 per cent. of the load on the engine has been absorbed in the shafting, or, more correctly, between the engine and the pulleys on the various machines. My own experience is that the average mills' losses in power due to friction, &c., *i.e.*, without any of the machinery running, is 35 per cent. These figures sound very high, and they are high. When one thinks that to-day many mills are using 100 tons of coal per week, and that out of that quantity 35 tons is being used to generate non-productive energy, does it not give us cause to look around and see where improvements can be made, and then reduce some of this unnecessary loss.

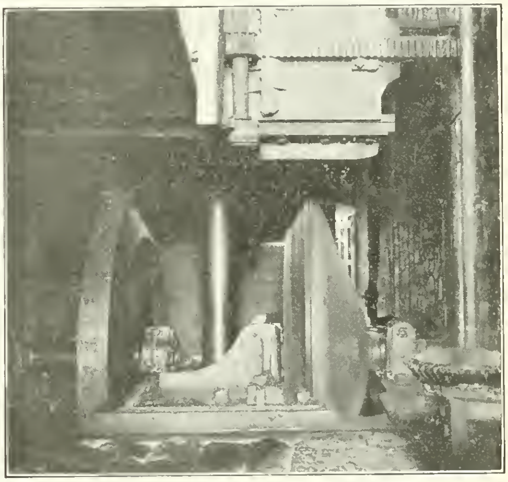


Fig. 1.—View of Bevel Gearing in a Yorkshire Mill which Absorbs Great Power, and was not removed until 1919

It illustrates the class of power transmission in the older types of mills to-day.

Figures for the Individual Drive.

Can the electric drive give us any thing better, can it reduce our friction losses? It has been proved time after time in this country alone, that it can, especially if the individual drive is adopted. Just for an example let us add up the losses which are caused through electric drives, let us see if we cannot show a great saving in power. There is a spinning mill in the Manchester district with each frame driven by a direct-coupled motor. The frame was tested before the size of motor was decided upon, and was found to take 4·85 h.p. when the frames were working in 50's counts. There are 100 of these motors installed, and a number of additional motors for winding, reeling, &c. A transformer was put in just sufficient to cope with the load, and likewise the cabling was on the best system, so that no heating took place under normal load conditions. The motors were of the high-efficiency type. The losses in an installation of this description would not, therefore, be more than :

Transformer	3 per cent.
Cabling	4 ,,
Motors	14 ,,
Total	21 per cent.

This, I contend, is a very liberal allowance, and should be improved upon to be at least under 20 per cent. However, it shows a very great improvement on the average steam and shafting drive, with its 35 per cent. Apart from any other saving, what does it mean in coal on the 100 tons per week basis? It means a saving of 14 tons per week, or, at present coal prices, about £875 per annum. Is this not a very important point, and one which should be greatly appreciated? It may not be so to-day, but when trade gets back to normal, and the prices of goods are effected by tenths of a penny instead of the present pennies in the shilling, it is bound to be a point of vantage.

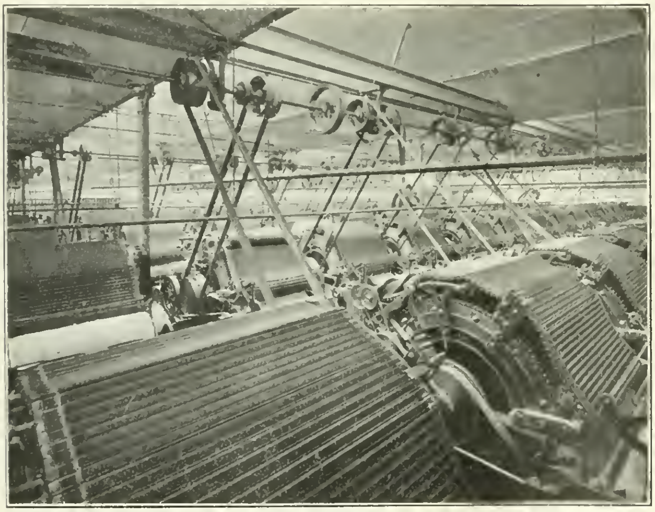


Fig. 2.—Typical View of a Carding Engine Room in a Large Cotton Mill.
Note amount of belting, which obstructs the light and should be cut down to a minimum.

Speed Variation.

Then comes the question of speed variation, a subject which has been so very much discussed in Bradford and Halifax district for the last four years. On this subject one has to speak with very great care. It is a subject which has not been properly considered, and the importance of which has not been grasped to the full by those who felt they were equal to electrically equipping a textile mill. Speed constancy is of vital importance to the fine spinner to avoid breakages of yarn, and give equal tension. It is the same for the manufacturer who is desirous of producing a firm and even material. It is of importance to all textile mills from a productive point of view and for the maintenance of quality. Experience has taught us that it depends entirely on how the drives in the mill are installed as to how steady a speed we obtain on each machine. It has also taught us that the same principle of group driving in Lancashire shows a much steadier speed on the machines than it does in a Yorkshire mill. This is due to the general layout of the mills and the size of the rooms.

On this subject alone we have one of the greatest inducements for the individual drive. Wherever a machine is driven by its own motor it can be guaranteed that the speed will be constant for every action of the machine, providing the same class of material is being worked. If the quality of the material is changed, the speed must change with it, but it will continue constant at this changed speed so long as the same quality of material is being worked. An interesting example of this was noted in a doubling frame not very many weeks ago. A firm throughout the war had been on one special quality of material, and the motor running the doubling frame was recording 95 per cent. of its rated output at a speed of 1,445 revs. per min. The tin roller shaft was running at 900 revs. per min. It was desired to change on to a different quality of material, and run at a speed on the tin roller of 850 revs. per min. This, of course, meant a change in the gear wheels between the motor and the tin roller shaft. These were calculated out, and changed accordingly, basing the change on the 1,445 revs. per min. of the motor. The result of this, when the machines were again set running and on this new quality, was that the power was little over 50 per cent. of the motor's rated output, and as a consequence of this the speed of the motor had gone up to 1,480 revs. per min., a difference of 25 revs. per min. on the motor and 20·5 revs. per min. on the tin roller shaft. Such a difference may be detrimental to good doubling—that depends entirely on the class and quality of the yarn—but it does show very forcibly two interesting points. One is that whilst we term a squirrel cage induction motor a constant speed motor, it has a certain amount of slip, and, secondly, motors when running well on top of their work run at slightly higher speed. These points have to be carefully considered before a plant can be installed which is going to give satisfaction on the question of speed constancy

The Dangers of the Group Drive.

Let me just enlarge on the danger of group drive in a spinning mill for a moment before I continue. An interesting case arose in 1914 of a mill which had rooms large enough to group only 13 to 15 frames on one motor. This meant that about 60 h.p. motors were installed. After the mill had been running on this electric drive for a few months it was found that the speed was varying very much more than was good for the yarn. The owners had been informed that with electric drive you could speed up slightly, and so get increased production. Whilst this is correct, the installation must also be correctly designed before it applies. However, we shall come to this subject directly. To continue, this advantage of constant speed allowing to increase slightly the speed led this firm to put their speed up to what I might term the maximum limit, and thus get the maximum production with maintenance of quality. What was the result? Out of these 13 frames one or two would be continually stopped for doffing; perhaps the draft wheels would be changed fairly frequently on one machine or another. This meant that the load on that motor was varying from full to, say, three-quarter load continually, and this meant the speed must vary slightly on the slip which it had between no-load and full-load. Admitting that this variation would be no more than 10 revs. per min. in a thousand, this will become 60 to 70 revs. per min. on the spindle speed, and not only that but it meant these number of revolutions above the maximum limit, so spoiling the yarn, and therefore reducing the production.

There are two things to be learnt from this, and in the larger mills there ought to be no difficulty in practising them. The first is that the grouping is too small—that is, one frame is a high proportion of the total load on the motor. The second is that we must arrange the grouping in such a manner that there is no need to change the frames or part of the frames on to a different count, and thus vary the power required to drive the frame. If the groups are only made large enough, and the frames as far as possible kept to one special line of yarn, then we can give constant speed, and so that slight variation will not affect the yarn, even if it is being spun on the maximum speed limit. Against this it may be argued that the larger the group the more eggs in one basket. I readily admit this, but I say again that if it is constant speed you want (you not only want it, but you must have it) then you either have to obtain it by large group drives or by individual drives, and the most sure way is to install the individual system, which incidentally puts each egg in its own basket.

Knowledge of Textiles Necessary.

I have enlarged rather on this question of speed variation, and have given these examples with one idea in mind—that is, that it requires the engineers who attempt to equip a textile mill to have not only a knowledge of the machinery he has to drive, but of the textile qualities of goods which are being worked. The engineer is sure that he can give constant speed to any machine providing the actions of that require the same power for any material. I go further than this, and I say a practically constant speed can be given on any textile machinery or group of machines if one understands the textile side as well as the engineering side.

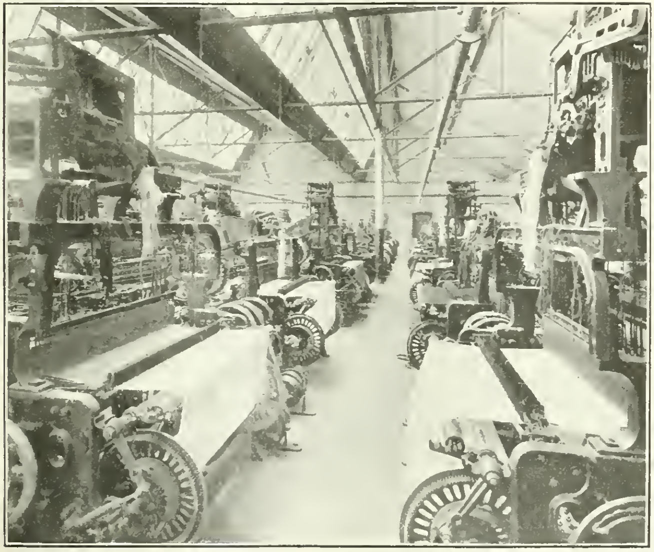


Fig. 3.—Typical view of how Weaving Mills should be driven—that is, each Loom has its own Motor.

Note the motors on the floor, and also the distribution box let into the floor.

Thus, we have three vital advantages, which can be secured with electric drive from an engineering point of view: (1) The supply of power from a common source with its splendid stand-by arrangements, and, in the near future, cheapness of supply; (2) the reductions of friction losses, and consequently less cost of running; (3) the advantages of a perfect speed, which allow of an increase in the speed of the machinery.

The Electric Drive from the Owner's Point of View.

Now let us turn our attention to the merits of the electric drive from the owner's point of view. Are there any advantages which it can show? What does a stand-by set do for the owners? Will it mean that he is very much more sure of being able to run his mill at all times and with a minimum number of stoppages? Is this not worth having, is it not a form of guarantee that he is going to get the most out of his plant if he has the minimum number of stoppages? Why, it is certainly a guarantee. During the last six months I have visited two mills steam driven with shafting, and found them stopped. At the first I inquired the reason, and was told that during the last nine months they have only been able to run one whole day without a stop, owing to steam trouble and inefficient engine and shafting. Not only that, but this firm have eight large boilers to feed a 1,200 H.P. engine. Such a thing does not happen in a supply station if it is adequately equipped. Such a thing as a turbine giving out, or an alternator burning out, means to the consumer that he may be stopped for only a few minutes until the duplicate set is run up. Secondly, what does the reduction of friction losses mean? This does not show any natural advantages apart from what we have already dealt with, so we pass to the third point of speed variation. If this variation is done away with, then we realise that a slightly higher speed can be obtained, and that, as we have pointed out, must mean increased production—that is, this increase means that the whole plant must be working more efficiently. What is the average efficiency in a textile plant? From information I have gathered from several mills from time to time, it appears to be very much the same for a spinning plant as for a weaving plant—*i.e.*, in the neighbourhood of 66$\frac{1}{3}$ per cent. During a recent visit to the West of Scotland I was discussing this question with a leading spinner, and he told me that this appeared about their average, but quite recently they had been taking a monthly test, extending over a week's production. They made no difference to the speeds of the machines, but the managers and overlookers just kept a more rigid control over the hands, and also took every possible piece of waste into use again. The result of this test showed an advantage to the firm of nearly 6 per cent. of the weekly production. As spinners or manufacturers, just for a moment pause, and think what it would mean to you.

How to Increase Production.

Here then is, say, 5 per cent. increase production by taking a little more care within the mill. May I take you a little further, and combine this increase with that amount which the electric drive at constant speeds is going to give. Let us see what can be obtained from the electric drive. This is a variable quantity for every mill. No hard rule can be made on this point, but from experience it has been found that in practically all the installations which have been put down, there has been at least 3 per cent. increase obtained due to speeding up. Let us take it at 3 per cent. then for the purpose of keeping on the right side.

The Effect of Constant Speed on the Material.

There is another point to be raised here before we can complete this total increase of production, and that is what effect has a constant speed on the yarn or on the material being woven. If we run at a constant speed then we not only have ourselves appreciated the fact that better quality is maintained, but we find that the yarn is not subjected to shocks or jerks, and is therefore more even in its diameters or texture, as the case may be. Let us see if we can do away with these shocks and jerks, and thus surely reduce the tendency to breakage. If we do this then our production must again naturally increase, and what is more— and counts, perhaps, more—is the fact that the quantity of waste is decreased. Thus so much more cotton, wool or flax can be sold at the price of spun yarn, and less at the price of waste. However, we see a further increase of production in this way, and we have to form some idea of what it amounts to. This can only be done from tests carried out in the mills, and we, therefore, have a concrete case to work upon. Many of us have seen statements to the effect that 2½ per cent. has been produced by this alone, and in some cases a larger amount has been secured, but 2½ per cent. appears to be about the average.

What is to be Gained by the Electric Drive?

Thus, we have 5½ per cent. increased production, which can be attributed to the electric drive. Let the millowner again pause, and consider what this means to him. What does it mean to a concern to-day, if they were to exercise this extra precaution against general losses in the mill, and also install the electric drive giving the results we have just considered? Does this not mean at least a 10 per cent. increase in production, does it not mean an increased production on the same standing charges, and therefore a cheaper production per lb. or per yard? Does it not mean further that they are in a better position to meet competition when it comes, and also to show a very much more favourable balance-sheet?

I do not go so far as to say I know what 10 per cent. increase means financially at the present time, for we hear of such varying profits. Each millowner can work this out for himself. At the same time, I have a little spinning place in mind at the moment with not more than 1,000 spindles, where if they had got these results the profit on this extra 10 per cent. would have paid in one year for the electric installation, and also for cost of running at 1¼d. per unit. Here then we have three further advantages besides the engineering advantages. Could we enumerate any more? I will do so very briefly. (1) Owing to the better facilities for measuring the power better records can be kept, and a correct form of departmental costing can be adopted. This must be an advantage worth having, especially where departments are put on a profit-making basis. (2) It tends to cleanliness throughout the whole mill: there is not the same quantity of oil used, there is not that constant worry of bearings getting hot. The first two of these points go to help to welfare of the employed. (3) Great safety precautions can be obtained and the fact that power is transmitted through cable instead of shafting, gearing, &c., gives an additional amount of confidence to the work people, who see less overhead gear in motion. (4) The millowner is in a position to take advantage of electricity for lighting at the same price as for power. Electric lighting gives a better light, and is an aid to healthy conditions, a point that has closely to be considered in the future after the reports which were published not very long ago by Sir Auckland Geddes on the subject of physical fitness in the textile and mining areas. (5) And so we could continue on advantages of smaller degrees, all of which go to make the electrically-driven mill installation the best and most efficient to adopt.

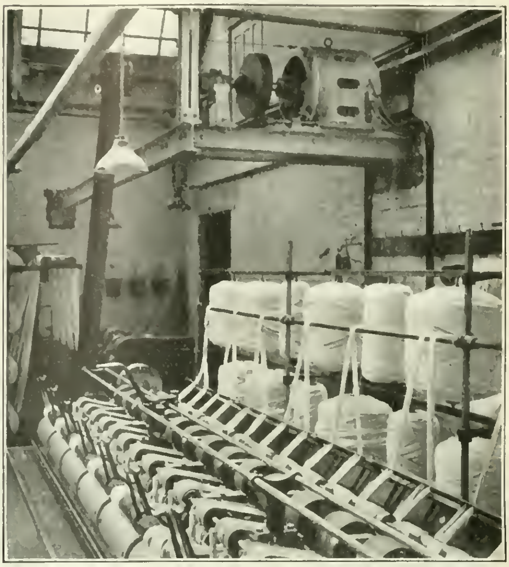


Fig. 4. A View of Line Shaft driven by Electric Motor in a very satisfactory manner.

Illustrating also a very satisfactory automatic centrifugal friction clutch by Messrs. Thomas Broadbent & Sons, Huddersfield.

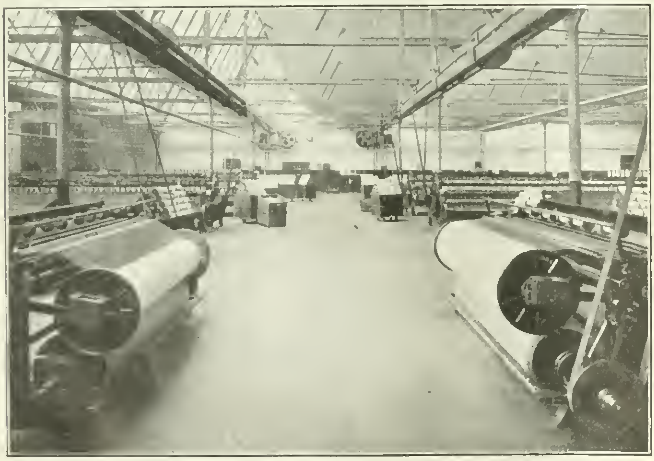


Fig. 5.—View of Splendid Drive arranged with Motors and Chains on to Line Shafting.

Note the motors and chains are out of the way, and not taking up floor space.

Improvements in the Electric Drive.

After we have dealt so fully with these points we may pass to the questions of further developments in the electrical gear which is being put into textile mills at the present time. In what ways can it be still improved from the millowner's point of view? If you have considered this matter so fully as I have, then I think you will almost be able to carry yourself away a great number of years ahead to a time which we shall never see. At the same time there are some forms of improvement which can be looked for at a comparatively early date. First of all I feel that we shall see great strides made in the manufacture of more efficient motors. Up to the present an appreciable effort has been made, but they can still be much improved upon. Also in conjunction with this efficiency much attention will have to be paid to the maintenance of a better power factor, not only to the motor, but in the whole installation. These two points alone can tend to make the running cost very much more favourable, and, secondly, if you can maintain a more satisfactory power factor, then there is likelihood of the supply company giving preferential treatment as regards rates.

We shall then have a very much larger adoption of the power recording meters. The advantage which these are in a factory have not yet been appreciated to the full, and it is only when we can get people to realise that every little bit of additional friction load increases the cost of running that we shall find them anxious to have every machine metered. An ammeter installed on every motor will be the future policy, except for such as loom motors, and where a small testing plug and set can be economically used. These meters should be marked with a red line at the full-load. If this is done then the manager or engineer, as he walks round, can see at a glance how each machine is running.

In the driving of ring spinning frames we must see improvements made in the form of a gear-box between the motor and the spinning frame. This will very probably be coupled to the lifter on the frame by which the thread is guided up and down the bobbin or cop. This gear-box will be used for the varying of speed, and will, to my mind, be a much more satisfactory way of doing so than by introducing the complications of a variable speed alternating-current motor. In this country this variable speed arrangement has not been tried to any great extent, but one has heard much about it on the Continent, where, as I said previously, a great deal of electric driving in textile mills is being employed.

Safety devices will come very much more to the front in these mill electric schemes. Very few people to-day, for instance, consider the necessity of putting no-volt releases on to the starters for the smaller power motors, say, 3 H.P. and upwards. To my mind these are of the utmost importance. Let me just give you one example of their necessity. You fit up the whole of your spinning frames with individual drives, the proper thing to do, and you break your main distribution circuits at 11.30 on Saturday morning. The girl seeing her frame slowing down, should then see that her motor-switch is in the "off" position. If it is not an automatic switch, then she would have to do this herself in a similar manner to that of transferring the belt to the loose pulley. Some girls have a reason for not doing these things. The result is that on Monday when the circuits are made alive, these particular motors are supplied with current instantly, and start to run, which they may do without any trouble, or they may not. In any case the risk is great, and should be avoided. The way to avoid it is the adoption of automatic features. The same applies to overloads devices.

Again, we shall have to introduce better foolproof switch and starting gear, and it will have to be of a more durable character than that which is generally supplied at the present time. There is no place I know of where more precautions are needed than in a textile mill, where you have men, women, boys and girls tampering with anything new which is introduced.

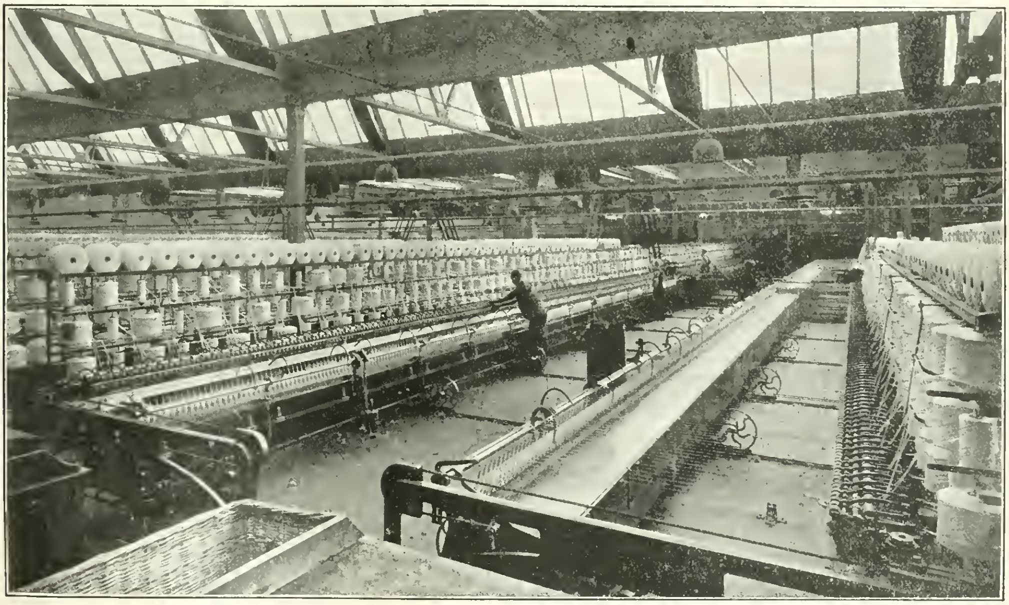


FIG. 6.—VIEW OF A MULE SHED EQUIPPED WITH ELECTRIC DRIVE INSTALLATION.

Note that each mule is driven by its own motor, which is suspended from the roof.

Then when we come to study the welfare of the employed a little more we shall have to introduce electric cooking apparatus in order that they can have a proper meal at midday, and have it heated up or cooked as the case may be, in a very much better manner than at present. The heating of mills electrically is sure to be tried, and very probably after many years of experiment, adopted. I am afraid we cannot expect much in this way for a very long time. However, it would be quite feasible to-day to do away with the boilers and heat the whole of the premises, heat the whole of the water required, and also the drying rooms electrically, but the cost would be very much against it.

Some Notes on Lighting in the Textile and Clothing Industries.

By J. S. DOW.

INTRODUCTION.

THE textile industry, as is generally recognised, forms one of England's greatest industries, and allied with it are various other industries, such as the making of dyes and of garments and the manipulation of cloth generally, which also employ a vast amount of capital. There is, perhaps, no better field for the study of artificial lighting. The complexity of the processes involved, and the machinery utilised, call for lighting of a very special character. It is significant that the textile and clothing industries formed two out of the three selected for investigation by the Departmental Committee on Lighting in Factories and Workshops, which reported to the Home Secretary in 1915. While the principles formulated in this inquiry are of general application to industrial lighting the textile and clothing trades also present special lighting problems of their own. It will be convenient to consider, *first* matters connected with intensity and distribution of light; *second*, the effect of colour in the illuminant.

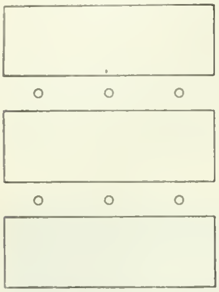


Fig 1.—Winding Frames.
The circles indicate position for 60-watt tungsten lamps with extensive reflectors.

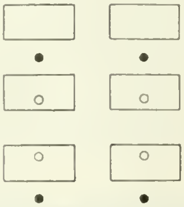


Fig. 2.—Weaving.
Black circles indicate position for 40-watt tungsten lamps with extensive reflectors. White circles indicate position of 60-watt tungsten lamp with extensive type reflector.

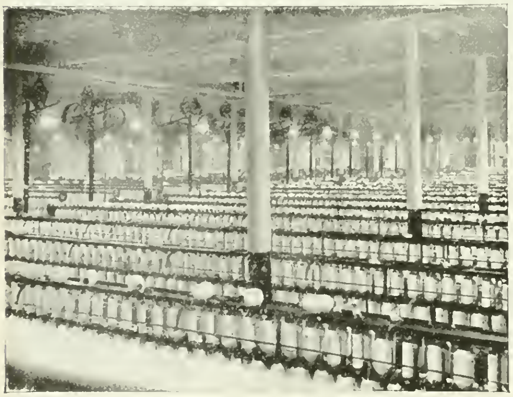


Fig. 3.—Showing Localised General Illumination in a Textile Mill.

Fundamentals of Good Lighting.—In the textile industry, as in others, the fundamental principles of good lighting formulated in the Home Office Report, apply, namely:—

1. Sufficiency of illumination on the work.

2. Reasonable constancy and uniformity of illumination over the area of work.

3. The placing or shading of sources so that the light from them does not fall directly on the eye of a worker, either when engaged on his work or when looking horizontally across the workroom.

4. The placing of lights so as to avoid inconvenient extraneous shadows on the work.

The conditions applying in purely textile work are somewhat different from those in trades involving the making of garments and in the clothing industry. Rooms devoted to textile processes, winding, spinning, weaving, &c., are commonly arranged with machinery in lines with gangways in between, and it has been usual practice in the past to allot lighting units to individual machines, with a view to concentrating light on the actual machines, and at the same time allowing sufficient light in the alleys. Figs. 1 and 2, for example, illustrate methods recommended in a booklet on industrial lighting issued by the National Electric Light Association in 1912. Fig. 1 shows the positions of lights along the alleys between winding frames spaced 7 ft. to 10 ft. apart. Fig. 2, relating to weaving, shows the combination of lights in the alleys with supplementary lights over the looms. Figs. 3 to 6, which are taken from the booklet mentioned above and for the use of which the author is indebted to the British Thomson-Houston Company, Ltd., also illustrate typical arrangements. Too much importance cannot be attached to the screening of lamps with properly designed reflectors, a point which is very clearly illustrated in Fig. 6.

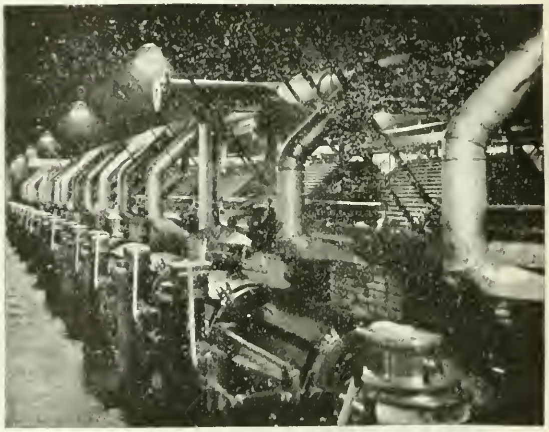


Fig. 4.—Local Illumination of Carding Machines by Lamps in Scientifically Designed Reflectors, the Height and Spacing being Selected to Avoid Glare or Branch Shadows.

Intensity of Illumination.—The American publication referred to recommended an illumination on the work of 2 to 4 ft.-candles for winding frames and from 4 to 6 for weaving. Probably one would be justified in saying that for textile work generally a minimum of at least 3 ft.-candles is desirable. The report of the Departmental Committee on Lighting in Factories and Workshops, issued in 1915, contained a considerable amount of data on lighting conditions in the textile industry, and gave an indication of the prevailing conditions, which seem capable of considerable improvement. Thus, the average illumination in weaving sheds, derived from measurements in a large number of factories, was found to be about 2 ft.-candles on looms and 0·4 ft.-candle on floor; in spinning sheds the average illumination on mules was recorded as 0·4 ft.-candle, and 60 per cent. of readings fell below 0·5; on the other hand, the average floor illumination was actually higher than this, namely, 0·6 ft.-candle. A general analysis of spinning mills showed that 97 per cent. of the mills visited had values of illumination under 1 ft.-candles. It is remarked that obstruction of light by machinery was frequent, and that gangways were often under-lighted. The Home Office Report referred to only attempted to specify the minimum floor-illumination desirable in the interests of safety (viz., 0·25 ft.-candle), and values of illumination necessary for the carrying on of work have yet to be determined. But in view of the above figures it seems highly probable that in a large number of mills the illumination might with advantage be very considerably increased.

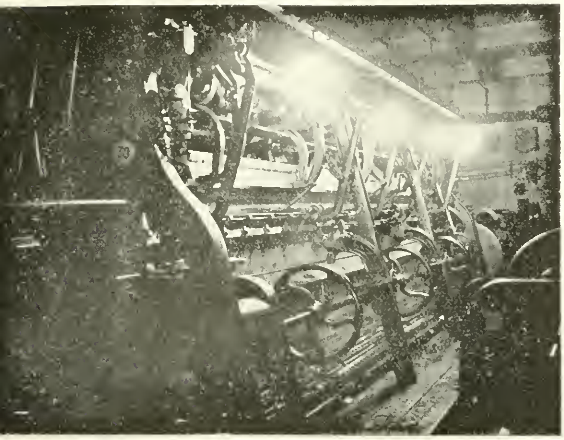


Fig. 5.—An Example of Very Bad Lighting with 64-watt Carbon Filament Lamps in Shallow Enamelled Iron Shades. The Illumination was Inadequate, and a Bad Feature is the Glare from the Exposed Filaments.

The following figures, taken from the Ohio Factory Lighting Code, may be of interest as showing the order of illumination recommended in modern practice in lighting textile mills in the United States:—

	Illumination (ft.-candles on work)
Cotton Mills—	
Opening bales, carding, slashing, ring spinning, roving, spooling, lapping, warping, packing and shipping...	2—4
Drawing-in, weaving, dyeing	3—5
Inspecting	10
Woollen Mills—	
Receiving, carding, dyeing, twisting	2—4
Washing, combing, picking, warping, packing, shipping	3—5
Weaving	4—8
Inspecting, perching	10
Silk Mills—	
Receiving, packing, shipping	2—4
Quilting, throwing, winding, warping, finishing	3—5
Weaving	4—8
Knitting Mills—	
Napping, packing, shipping	2—4
Knitting, looping, seaming, finishing, inspecting	3—5
All Mills—	
Roadways and thoroughfares, yards	0·4—0·5
Stairways, passages, elevators	0·5—2·0

Indirect and Semi-indirect Lighting.—While the importance of avoidance of inconvenient shadows might seem to favour indirect methods, the low ceilings in many existing mills would prove a difficulty. The danger of too complete diffusion of light leading to very soft shadows such as are unfavourable for the inspection of threads and the texture of knitted or quilted surfaces, must be guarded against. Possibly the most recent forms of industrial indirect lighting units, involving the use of a half-silvered lamp under a shallow diffusing reflector, may have a useful application in this field. In some of the American mills indirect and semi-indirect methods appear to have been used for knitting and finishing rooms with good effect. One point deserving notice is the danger of glare from polished surfaces of knitting needles, &c., and it has been claimed that indirect lighting is advantageous in mitigating this difficulty.

When Local Lights are Useful. It cannot yet be said that local lighting is to be superseded by general overhead lighting, though the latter has manifest advantages. In some cases where workers obstinately cling to the local lamp, their prejudice against general lighting has been traced to the fact that less illumination was usually available. Now that it is practicable to provide a really *high* general illumination this objection largely disappears—at least with light materials. It is, however, still doubtful if general lighting answers satisfactorily with dark materials. In some cases the absorption of light may be so great that only by local lights can the brightness of the material be conveniently made sufficient. Further, with general lighting, the interior of the room as a whole is bright. When work is done on light material this is no drawback, and even an advantage; but it does not seem desirable that the actual brightness of work should be *much less* than that of surroundings—as may be the case if the material is very dark. On the other hand, if local lights are used, they must be well-shaded, and there must be moderate general illumination in the room to avoid contrasts in the opposite direction—*i.e.*, surroundings very much darker than the actual brightness of material worked upon. For the close inspection of some such surfaces a shaded local lamp is often preferred, as the direction from which the light comes can be easily altered; very oblique rays of light (in fact, almost uni-directional lighting) are often useful in revealing irregularities of surface, the texture or (in silks and satins) the degree of "sheen" or "glitter."

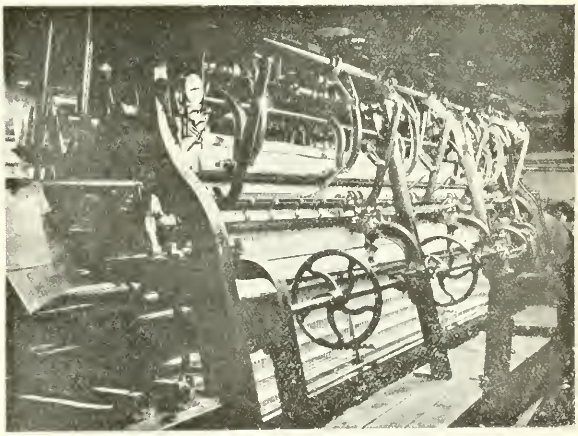


Fig. 6.—A Great Improvement on the Methods shown in Fig. 5. Six 40-watt Tungsten Lamps in Properly Designed Angle Reflectors (Mazdalux) were Substituted.

This gives a saving of 80 watts and improved illumination. The bottom of the loom being so lighted that it is unnecessary to bring down the batten of lights when a thread breaks (as had to be done with the arrangement shown in Fig. 5). Also the filament is shielded from the eyes of workers.

Effect of Artificial Illuminants on the Appearance of Colours.—We come next to an important matter in connection with the lighting of mills devoted to textile processes—namely, the colour of the light. This factor is of more or less consequence in all cases where coloured materials are dealt with; in the dyeing industry, both in works where dyes are produced and in factories where they are utilised for dyeing materials. As is well known, the appearance of colours in general is quite different by artificial light from daylight. The great majority of artificial illuminants (owing primarily to the fact that their temperature of incandescence is much less than that of the sun) yield a light which is richer in the red and orange end of the spectrum, and poorer in the blue and violet, than is daylight. True, the more modern illuminants come closer to daylight in this respect; the gas-filled ("half-watt") lamp, for example, yields a "whiter light than the ordinary vacuum tungsten lamp, and the latter is whiter than the carbon filament lamp; but the variation from normal daylight is still quite marked. We are speaking now of the artificial illuminants which yield a continuous spectrum, and for which correct colour-revelation is at least a possibility. In the case of those illuminants which yield line spectra, such as the mercury vapour lamp, and some type of flame arcs, accurate colour matching can hardly be expected, for some wave lengths are missing and others are exceptionally prominent.

Naturally the relative appearance of mixed colours (and almost all dyed fabrics are mixed or composite colours) is changed by this disparity in blue and violet and excess of red, orange and yellow. A purple or mauve colour, for example, *i.e.*, a mixture of red and blue, may appear much nearer akin to red by artificial light than is the case by daylight. Often surprising and unexpected results are produced. Two shades which appear to match exactly by daylight no longer appear the same by artificial light; conversely, one can find tints which are indistinguishable by artificial light, but are clearly not the same by day. It must be borne in mind that an apparently simple colour used for a dyed fabric may consist of quite a variety of constituent colours, some of which are accentuated, while others are depressed by exposure to artificial light. Prof. Roberts Beaumont, of Leeds University, explains in his work on standard cloths that khaki is a mixture in specified proportions of drab, bronze, brown, sage green, buff and blue; Belgian and Russian khaki have a different colour-specification from British khaki.

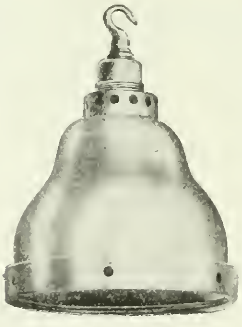


Fig. 7.—Benjamin Colour-Matching Unit, using Screen devised by Dr. Kenneth Mees.

A Standard of White Light Wanted. When only a very general idea of the appearance of colours is desired it may be possible to work by some forms of artificial light, though even in these circumstances one would choose an illuminant—a white flame arc, for example—which comes fairly close to daylight. But when accurate colour-matching is necessary work by ordinary artificial lights is scarcely possible. Even daylight has to be selected with care. In this country unfortunately daylight is a very variable quantity. We have as yet no recognised standard of white light, but the colour of light from an average white diffused north sky is commonly taken as the standard. The light from a white sky differs considerably from that received from a blue sky, and is again different from direct sunlight, though the difference in these cases is less than the difference between daylight and artificial illuminants. There are, however, many days in winter when daylight is unsuitable for accurate colour matching, and work has to be suspended. Fogs, smoke and mist may alter the colour of natural light and very seriously reduce its intensity. Moreover, one can never be sure that work may not be interfered with by some sudden climatic change, and in any case the time during which accurate colour-matching is possible by daylight is limited during the winter months.

Artificial Daylight. Now if one could modify the light from some artificial source so as to resemble daylight exactly in colour, this would be a great aid in colour matching. Not only might we obtain an easily manipulated and regulated colour-matching light, but we might secure a light of substantially constant value, free from the marked variations in colour and still more in intensity that characterise daylight. We should then be able to conduct colour-matching operations irrespective of climatic variations. But (and it is a big but) we must be sure that the "artificial daylight" thus secured *is* equivalent to normal daylight, or sufficiently near to it for practical purposes, and that it is not subject to variations, either progressive or irregular.

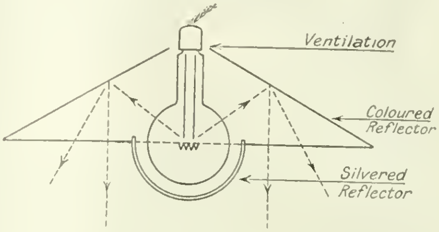


Fig. 8.—The Sheringham Daylight.

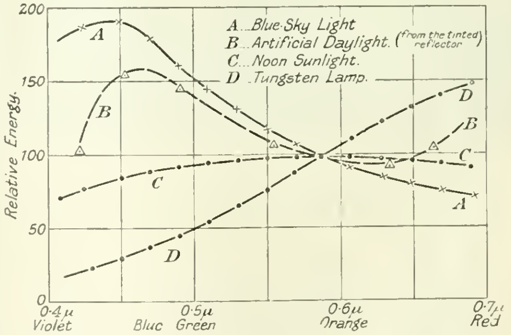


Fig. 9.—Distribution of Energy in the Visible Spectra of various Illuminants compared with that of the Sheringham Daylight.

Methods of producing such a colour-matching light have been the subject of discussion before the Illuminating Engineering Society on several occasions, and the whole subject was reviewed at a discussion on January 27th last. A brief history of efforts in this direction was recently given by Mr. A. P. Trotter.*

Colour-matching Glasses and Filters.—One of the earliest attempts to provide a colour-matching unit was that made by Prof. Gardner, of the Bradford Technical College, who utilised a "subtractive" method, *i.e.*, he devised a screen which exercised selective absorption of the excess of red and orange rays.

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* "Times" Engineering Supplement, Dec., 1919.

As soon as metal filament lamps came into use attempts were made to produce artificial daylight from this source. On the occasion of a discussion before the Illuminating Engineering Society in 1910 Dr. Kenneth Mees showed a form of units of this description, using a dyed gelatine in combination with coloured glass, a method which doubtless more readily facilitates accuracy in obtaining the necessary colour-tint, but which obviously calls for care. The screen thus prepared is placed under a metal reflector containing the lamp. Fig. 7 shows the colour-matching unit as now manufactured by Benjamin Electric, Ltd. The screen is stated by Dr. Mees to have great permanency, and to be not only visually but photographically correct as regards colour. The exact simulation of daylight naturally entails a considerable loss of light, and with this screen only about 15 per cent. of the original light is transmitted. Were one content with a more approximate result the efficiency could doubtless be increased. It is also probable that the gas-filled lamp, with its appreciably "whiter" light, will render possible units with a considerably smaller loss. More recently Mr. Lionel Pearce showed at the British Scientific Products Exhibition a small and compact form of unit using an incandescent lamp with a coloured glass screen.

Special Coloured Reflectors.—The latest attempt to produce a colour-matching unit, the "Sheringham Daylight," was exhibited before the Illuminating Engineering Society by Mr. L. C. Martin, in November last. This device depends upon a different principle. It is "subtractive," but the removal of the excess of red and yellow rays in artificial illuminants is achieved by reflection, and not by selective transmission. The general nature of the lamp is illustrated in Fig. 8. Above a gas-filled lamp, the lower half of which is obscured or covered with a reflecting surface, is placed a large conical reflector, the inner surface of which bears a mosaic of different colours. These colours are so selected that the reflected light is converted into a close resemblance to daylight. Either north white skylight, blue skylight or diffused sunlight can be imitated: the spectrum composition of these varieties of daylight is illustrated in Fig. 9. It is as yet too early to pronounce on the possibilities of this new method, which has some interesting features. The diffusion of light from a relatively large surface would be advantageous in many cases, notably when it is desired to flood with light a relatively large area.

Considering its importance to the textile and dyeing industries, it is surprising that "artificial daylight" has received such a comparatively small amount of attention. The matter is one in which such bodies as the Textile Institute might well interest themselves, thus giving a practical application to the principles which the Illuminating Engineering Society is now studying.

The Development of Electric Supply to Textile Mills.

By W. BROWNING, M.I.E.E.

A Troublesome Question.

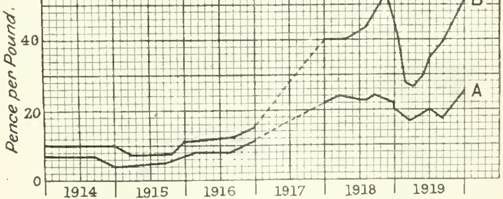
How often has such a title as the above caused the article to be eagerly scanned in the hope that it will contain a simple solution to that troublesome question: Does it pay to drive a mill electrically, and should private plant be installed or should the power be obtained from an outside supply? There does not seem to be any formula for this, at least one is not known to the writer.

Many phases of this subject are pure engineering, a matter of steam consumption, evaporation and calorific values, iron, copper and friction loss, and although there is much difference of opinion to be found when these points are discussed, the differences are generally due to incomplete experimental data, rather than to lack of knowledge of the fundamental grounds of the subject. When, however, the electrical engineer enters a textile mill he is in a world of different values to that in which he was trained and ignorance or lack of the full appreciation of these has led to mistakes of application, of which there are some well-known examples; one often wishes these would stay dead and not rise up to haunt the steps of the advance scouts of the electrical industry. The object of this article is to emphasise and illustrate some of these special points of view of the textile world.

The Outlook of the Mill Manager.

If one were to sum up the outlook of a mill manager in a word, one could almost completely describe it by saying, output. His first and last thought is that nothing must hinder output. This is true of all manufacturing processes, but more so of the textile, and probably it receives the greatest emphasise in the cotton spinning mill.

The present-day capital values of the textile world are reflected in the published prices of the many recent mill sales, but what is probably less known is the "margin" of the cotton spinner: that is, the difference between the price of the raw cotton and the price of his finished yarn. The mill sale prices during January showed values per spindle varying from 45s. to 105s., and these are not by any means the cost of a new mill at to-day's prices. Couple this with the output of 0·85 lb. of 32's American twist yarn per spindle per week and the margin indicated in Fig. 1, and an indication of the relative values of raw material and finished yarn to capital charges will be seen. These two facts then, the high capital value of the mill and the small increment in the value of the material in its passage through the mill, make output of vital importance. Similar considerations rule throughout all branches of the textile trade, and though most of the references in this article are to cotton spinning mills, the conclusions apply with equal force to a doubling mill or to a weaving shed.



Curve A *shows price of American Fully Middling Cotton.*
Curve B *shows price of 32's Cop Twist Yarn.*

Fig. 1.

The majority of textile mills are concerned with only one process, so that their staff organisation is very simple. Except in the case of a group of closely related mills the buying of cotton and all material used is in the hands of one man who also is responsible for the inside running, the quality and amount of the output. Even in the case of a concern where an inside manager is employed the buyer of the cotton is in command and intimately concerned with the results obtained, for there is no Mathiesson's standard for his starting point. Thus anything that enables him to give a larger attention to the buying of his cotton and reduces the time to be spent upon the additional duties is a help towards a larger output. Such an assistance would have an advantage apart from increased output, for it is commonly said that more money can be made by the skilful buying of cotton than by spinning it into yarn.

While speculation in the cotton market is looked down upon by the more thoughtful section of the textile industry and denounced as a hindrance to sound trade, yet it is true that close attention, the day through, and quick judgment is necessary in the buying for trade purposes alone, it being impossible for a spinner fully to cover himself. There is similar need for close attention to the yarn market, though there is not in this case the "future" market to watch.

The consideration of these facts takes or should take a prominent place in the discussion for and against the purchase of electrical power from an outside source, and it has been the experience of the writer that they have generally been the deciding factors in favour of the outside supply.

Disadvantages of the Purchase of Power.

The purchase of power has, however, two disadvantages which carry weight in the eyes of many textile people. They are the increase in the running costs by the inclusion of the proportion of capital charges of the station in the monthly power account and the fact that these cannot be reduced by liberal writing off the capital cost in times of good trade as a provision for a rainy day. Then, in the case of the larger installations, there is the increased cost of the power purchased above the cost of generation that is possible with plant on the premises.

These objections are, however, generally over-ruled when the relief of the manager in regard to the supervision of the purchase of coal—a matter of no little worry in these times, though not for ever, let us hope—and the control of boiler and engine room staff is fully considered. The coal question will be readily conceded, though there will remain some coal to be purchased for the boiler supplying steam for the heating of the mill and the slashing room of the weaving shed; but in the matter of the labour it will be evident that the introduction of motors does not always reduce the engineering staff.

The value of the relief to the management of a mill is, however, best appreciated by those directly interested in the profits of the concern, and the writer must record his personal observation that there is a growing recognition of this relief in the minds of several prominent and successful textile mill-owners. There are now signs which lead even one not in close touch with the textile trade to the same conclusion; for some of the most successful cotton-spinning concerns are now buying power.

Strong emphasis, the writer holds, may be placed upon the fact that they are successful, not, however, suggesting that their success is due to their lack of generating plant of their own but that the management that is capable of making their concerns stand out above the general run also think it worth while to scrap their power plant and buy electricity.

Three Typical Cases of Electrification.

Take three typical cases as an illustration:—

No. 1 Mill is in Oldham with an Oldham directorate. The engine plant was worn out, the building was good, a conversion to electric driving could be made without much loss of production; electric driving was decided upon, but instead of installing a steam turbine plant, similar to a neighbouring mill, they decided to purchase power. The outsider does not know the details of the discussion inside the boardroom, but he notes that this mill is the centre of a very successful and growing group of cotton interests, all being developed on similar engineering lines, and comes to the conclusion that they consider the relief due to the absence of power plant is worth while from the larger point of view of the mill as a whole.

No. 2 Mill is near Manchester. There were two mills run from the same boiler plant, and adjoining one of them was spare land. To build a mechanical mill gave less spindles than an electrical mill, but apart from anything else, the extra spindles did not seem, to an outsider, to give enough extra production to meet the extra power costs. It was decided, however, to buy the power, and these three mills have recently changed hands at such a figure that indicates that the electric mill is not a white elephant.

No. 3 Mill is in Bolton. This, similar to the first case, is an old mill with an old engine, but the engine was not at its last gasp, and extensions were desired. These were decided to be electrically driven from Corporation supply.

The mill has been driven in this manner for some years and, taken as a whole, has been a financial success though naturally the running costs of the electrical portion, as in the second case, are stated to be excessive when compared with steam-driven portion. Yet these excessive costs have not proved a deterring factor, for the old engine is to be replaced by electric motors with Corporation power to the total of 1,250 H.P. It should be noted that in the cases of mills 1 and 2 it would have been possible to instal a private steam turbine generator, while in the instance of No. 3 mill, a rope drive could have been arranged.

So far we have been considering the problem of electric generation by private plant *versus* supply companies' plant. Now this last mill affords an illustration of the manner in which electric driving itself appeals to the textile mind. The first electrical installation of this consisted of 700 odd horse-power of motors, while the mechanical drive was some 800 I.H.P. The 800 was to be increased to 1,200 by further extensions, and a slow-speed engine of 2,000 I.H.P., with rope drive was planned to drive the mechanical portion and also the electrical portion by means of a flywheel type generator on the crank shaft. A large defect in this scheme was the interference with the production that would occur during the change-over. This defect or inconvenience on the one hand, coupled with fact on the other hand that the whole of the space now occupied by the cooling water lodge would be rendered available for productive use by the dropping of the mechanical scheme, turned the scale in favour of electrical drive from the Corporation.

Tower water-coolers might have been installed, but they are not regarded with favour because of the obstruction to light that would result, and in view of the increasing rateable value of the ground, the productive use of all space is keenly watched.

When the Electric Drive has no Chance.

Thus, where there is no improvement possible in the internal arrangement and running of a mill, electric driving from their own plant has no chance of success. Take as example the case of a spinning and manufacturing concern in the Midlands, which had an old steam plant driving one section and a suction gas engine driving the other. The steam plant wanted renewing, and the gas engine was running very badly. There was space to build a new steam turbine house, and the proposal submitted was to drive the whole place electrically. When examined critically it was found possible to build a new engine house at the spinning mill, drive this by ropes from the flywheel and by means of an extended crankshaft and a second driving flywheel pulley to replace the gas engine without interference with the running during the change.

The first scheme was ideal from an engineering point of view, but it was the simple replacement of the ropes by motors, and the interest on the extra capital outlay was met by the coal saved by the better plant. From a national point of view they should probably have adopted the electric drive, but it would have been an increase in the unproductive capital of the concern, and so the decision favoured the mechanical scheme.

There are similar examples to the above that have been installed in the hope that the steadiness of running would be the redeeming feature, but this has not been upheld, and the cases are written down as unsuccessful.

Another instance of the dropping of the electric scheme because the internal economy of the mill could not be improved by it is that of a group of mills under one management, all taking their engine condenser cooling water from one lodge. Two of the engines totalling 1,500 I.H.P. were to be renewed. It was possible to replace them by a single engine with good connecting drives to both mills. The possibilities of a turbo-generator were explored, but the lowering of the temperature of the cooling lodge to obtain the higher efficiency of the turbine reduced the boiler efficiency of the whole plant, due to the condensers being of the jet type. Electrical transmission had no advantage to outweigh this loss and the mechanical scheme was adopted.

Generalising again, it is the convenience of electric driving, expressed in terms of the output of the mill, that is a measure of the success of any installation. This must not be sought for in concrete figures, for as such it is extremely difficult to investigate, everyone concerned being too busy smoothing the way of the cotton, wool, flax or silk through the mill. It is to be found in the instinct or judgment of the persons interested.

Stress has been placed upon the advantage of having no power plant, but, generally, as in the above examples, this is also grouped with some other advantage, such as the flexibility of arrangement, greater economy of space, or the elimination of some objectional gear or shaft drive. Whether the absence of plant standing alone will win the approval of the textile world has yet to be tested, and the future of the new mills driven by purchased power, now building or to be built in a cotton-spinning district, will be keenly watched by many to ascertain if this adventure is a success or no.

The Steadiness of the Electric Drive.

Much has been made in the past by electrical engineers of the usefulness of the steadiness of a motor drive, but here anticipations have not yet been entirely fulfilled. The bulk of electric supply is from turbine-driven plant, and the smoothness of the speed curve from such a source cannot be attained by any reciprocating engine. The motor reproduces the speed curve of its prime mover, wherever it is, while the elasticity of the ropes from the engine slightly intensifies the irregularities of its drive, and all irregularities of load alter the twist of the line shaft.

Now the majority of cotton and wool is spun by mule spindles with their irregular load, and from many tests of the quality of drive along line shafts the astonishing fact is revealed that irregularities as large as plus and minus 3 per cent. have been found to exist where the spinning was declared by all concerned to be ideal. Above this figure the spinning begins to be noticeably poorer, and at points where the irregularity approaches plus and minus 6 per cent. complaints are received from the spinners. There is, however, so much difference in the individual spinners and in the spinning mules themselves that again any exact detailed investigation is difficult. Judged from an engineer's point of view there must be some effect from all variations, but below the smaller figure given above these do not appear to act as a hindrance to the output, for this is the point at which complaints of broken ends are made by the spinner, whereas the faults that do not cause a broken end during the spinning must pass into the finished product to produce a general lower quality.

The remedy is probably the individually driven mule. This has been done experimentally, but except in the woollen trade has no length of experience behind it. Here the steady prime mover speed is delivered to the mule uninfluenced by the variable load of its neighbours.

With ring spinning the steadiness of the motor has little, if anything, to commend it against a good engine and rope drive for the steady load of the ring frames causes little variation in the twist of the shaft, and unless some other cause such as has been already outlined is present, the motor drive as such has no attractions except in the form of individual motors to each frame. Should electrical driving be decided upon for any reason in a new installation, the cutting out of the line shaft and belts are good and decisive points in favour of individual motors. The extra capital outlay is more than met by the saving of the power that results from the stopping of the motor for "doffing" the frame, and in addition there is the improved lighting and cleanliness, which are very valuable in some grades of work.

The Development of the Individual Frame.

There is an objection to the individual frame in some instances, in that the space of the motor is greater than that taken up by the fast and loose belt pulley, and that this space might be used productively. This objection is serious, and so great is the economical pressure that in the cases of the older narrow mills the passage ways are cut down to the last half inch, else the cost of supervision becomes too great. In a new mill, however, the value of wide passage spaces is becoming more recognised as a factor making for success, and where the few inches more space that is required for the individual motor can be readily given the individual motor has a good case.

There is a development that is likely to make the individually driven frame a desideratum even when compared with a mechanical drive. This is the interaction between the rising wages for the low-grade labour used in "doffing" the frames—that is, replacing the filled by empty bobbins—and the variable speed motor. The variable speed allows a larger ring to be used in the spinning, when output is gained by the higher speed that is possible on the larger portions of the bobbin, besides resulting in a saving in subsequent operations. This is one of the instances in which the textile trade is ready and waiting, and where the electrical engineer is the laggard. Let there be put on the market a variable-speed motor that needs as little attention as a loose pulley, and this method of driving ring frames will become a prime reason for the electrification of mills.

In the case of weaving there is again a decided bias towards individual motors directly it is decided that the transmission of power must be electrical. But in the application of individual motors there are precautions to be taken which the electrical engineer is likely to overlook. The good results of some of the early small experimental installations were not repeated when large installations were put down. In one there was trouble with the humidity and after many false attempts at the solution it was found to rest with the motors. The heat arising from the losses of the motors was of a similar magnitude to that which would have been caused by the line shaft friction, but its starting point was at the floor instead of overhead, and the hot air arising from the whole floor area was sufficient to baffle the current of air from the humidifiers and prevent its reaching the loom. This effect was not apparent in the small installation. With the cause of the trouble located remedy was not difficult.

The second difficulty arose in a case where the increased output obtained in the small experimental installation was not maintained in the large shed. Here the trouble lay with the system of working. The weaver herself had to remove faults and marks from her work, such being the particular means taken in that shed to maintain a high standard of work. This proved the limiting factor to the output of the weaver, and the extra efficiency of the individually driven loom went simply to increasing the length of stoppages.

Thus it will be seen that the future of electric driving in textile mills depends upon a sympathetic appreciation of the internal conditions of the mill. The engineering profession, however, can be encouraged to research and probably to lead in the development of the textile industry, for it is a live subject, and the mill owner himself is not at all clear of the limits of his own field. His views of the factors governing his interests are becoming more and more extended, for a well-known Lancashire textile magnate has been heard to terminate an argument in favour of the purchase of power with words to the effect that the smoke problem, being one of vital importance to the well being of the community, is also one for the trade, and one which should in discussion of this subject be allowed to have due weight.

Gas Engines for Textile Mills.

By J. G. WALTHEW, M.I.Mech.E.

NOTWITHSTANDING the rapid growth of the gas engine business during the past ten years in both small and medium-sized power units, it cannot be claimed that any very considerable progress has been made in the application of gas engines for the driving of textile mills. Before the war, a certain amount of development was in process, but during the war—when the various manufacturers turned over their works to the production of war material—all further development of gas power in the textile mills, with few exceptions, was arrested. Since the war, the manufacturers have had their shops so full with orders for gas and oil engines for general purposes, in connection with both home and export trade, that any further development of gas power amongst the textile mills has remained in abeyance.

Reasons for Small Use of Gas Engines.

In considering reasons for this comparatively small volume of gas engine business we find it is due, firstly, to steam being required for heating purposes in the mill; secondly, to the high combined efficiency of the steam engine in conjunction with the mill steaming arrangements. Again, if we take into account the pre-war prices of coal, the margin of saving possible in the fuel costs—in favour of gas power over steam power—was at that time insufficient to induce millowners, with a few exceptions, to change over from steam power. Since, however, the price of fuel has increased so enormously, this whole question is well deserving more attention by those concerned.

As regards the question of "reliability" of the gas engine, the writer holds the opinion that the modern type gas engine of moderate power is fully as reliable as the steam engine. True, the gas engine is not able to deal with an overload as will the steam engine, but this fact must be duly taken into account when determining the size of gas engine to be installed. Any uncertainty there may be in connection with gas power is oftener than not found to be due solely to the gas supply—that is in connection with the gas producer plant. In many instances in the past the question of providing suitable stand-by arrangements at the gas plant has been entirely ignored, and the means provided for observing the inside working of the gas producer altogether insufficient. Faults such as these are remedied by making suitable provision for the attendant to be able to ascertain at any time the "quality" and the "quantity" of gas that is being produced. He should have means of getting this information, just as the boiler house attendant knows the steam pressure by observing the pressure gauge.

The Advantages and Disadvantages of Electric Driving.

The chief problem to-day in the textile mills is how to increase the output, without in any way interfering with the present production. That fact accounts largely for the growth of electricity in the textile mills. Extensions to the machinery are more readily dealt with in this way than by any other, if a supply of electricity is available. Again, the general labour shortage, has, during and since the war, compelled the millowners to purchase such extensions to their power requirements that were available in the markets, and in this respect it has been easier to obtain motors than either steam or gas plant. It is well to refer in detail to these matters, otherwise some of the reasons for the growth of electricity in textile mills are apt to become obscured, and a wrong impression is created that electricity has scored on its merits, being better from every standpoint. Clearly such is not the case, and so far as "power costs" are concerned, the following figures will serve to illustrate it.

Before the war there were many cotton mills in and around Oldham where their steam engine power cost *less than sixpence a week per indicated horse-power developed*. These results were on the basis of a fuel consumption of 1½ lb. to 2 lb. of coal per indicated horse power hour, and with coal costing 10s. a ton or less. The hours of working were 55½ per week. In making a comparison with present day conditions, coal may be reckoned at 30s. a ton, and in calculating the "power costs" for steam, gas and electricity we will assume a textile mill absorbing 500 H.P. and operating 48 hours a-week.

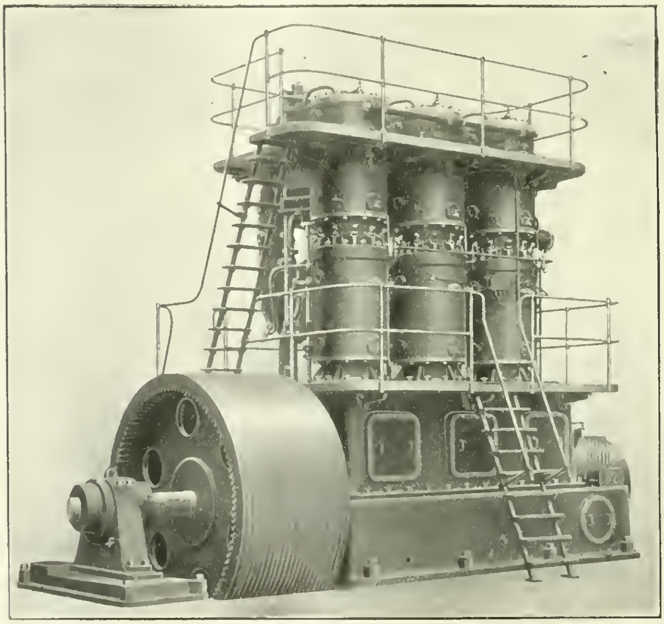


Fig. 1.—760 I.H.P. Westinghouse Gas Engine.
(Installed at Messrs. The Hollins Mill Co., Ltd., Marple.)

1. *Steam Engine.*

Coal consumption—	
Per indicated horse-power hour	1·75 lb.
Per week, 1·75 × 500 × 48/2,240	18·75 tons.
Per annum, 18·75 × 50 weeeks	937 tons.
Fuel costs per annum with coal at 30s. ton, 937 × 30/20	£1,405
Add labour costs for engine and boiler, say	550
Total	£1,955

Steam.—Fuel and labour per I.H.P. hour = 0·39 pence.

2. *Gas Engine.*—

Coal consumption—	
Per indicated horse-power hour	1·125 lb.
Per week, 1·125 × 500 × 48/2,240	12 tons.
Per annum, 12 × 50 weeks	600 tons.
Fuel costs per annum with coal at 30s. ton, 600 × 30/20	£900
Add labour costs for engine and gas plant, say	550
Total	£1,450

Gas.—Fuel and labour per I.H.P. hour = 0·29 pence.

In determining the fuel and labour costs for the gas driven mill, no credit has been shown for any by-products recovered at the gas producer plant. With installations somewhat larger than 500 H.P. it pays to recover the sulphate of ammonia, &c., and as may be seen from the example given later of the Hollins Mill plant, the receipts from the sulphate and tar cover the labour costs in attending to the gas engine and gas plant.

3. *Electricity.* From recent inquiry made as to the present day charges for electricity, purchased in bulk for textile mill driving, about 500 H.P. demand, this was found to vary from about 1·02d. to 1·5d. per unit. Basing our calculations upon 1·125d. per unit, and assuming an average overall motor efficiency of 90 per cent., then :

Cost per horse-power hour, 1·125 × 746 × 100 ÷ 1,000 × 90... 0·93d.
Power costs (neglecting all labour costs) :
Per annum, 500 × 48 × 50 × 0·93 ÷ 240 .... £4 650
Electricity.—Power costs per H.P. hour = 0·93 pence.

From these figures it may be seen that the electrically-driven mill of 500 H.P. costs £3,200 per annum more than does the gas-driven mill, an increase of 220 per cent. This large increase does not take into account any labour charges for the electrical driving. Now, the most enthusiastic advocate of electrically-driven mills will not contend that the starting up of motors and the care of electrical equipment generally for a mill of this power requires no attention. On the other hand, expert attention is required. Moreover, the starting up of motors, say, in connection with the group driving of carding engines, must be done slowly to avoid overloading the motors. Instances are on record where slow starting up each time has resulted in a very seriously diminished output (as much as 10 per cent.) which involved either putting down additional carding engines or making some other arrangements. It is also admitted that to drive looms individually requires something like 20 per cent. more power than group driving, and yet individual driving is on occasion recommended. Why is this ?

Types of Gas Engines in Use.

Referring now to various types of gas engines of moderate power, Fig. 1 illustrates a vertical six-cylinder tandem gas engine of 760 I.H.P., built by the British Westinghouse Company, and erected by them at the Hollins Mill Company's premises, Marple, in November, 1907. This affords a notable example of development work successfully carried out 12 years ago in connection with cotton mill driving, and by the courtesy of the spinning mill manager, the writer is able to add the following notes since making a recent visit to this mill.

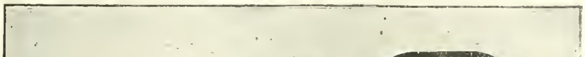


Fig. 2.—500 B.H.P. Premier Gas Engine. Four Cylinder, Horizontal Type.

So far as fuel economy is concerned, the gas engine is considerably cheaper than electricity or steam, but the maintenance costs are higher. A point of interest is that steam required for the blast pressure at the gas producer plant is raised from a "Bonecourt" waste heat boiler, coupled-up to the exhaust pipe of the gas engine. A very simple and effective arrangement for the recovery of sulphate of ammonia from the Mond gas plant has here been developed, which results in over half a ton of sulphate being obtained per week. In addition to this, about 1½ tons of tar per week are obtained from the gas plant. It is found that one ton of this tar when burned underneath a steam boiler is of more value than a ton of coal. Thus, taking the present market value of sulphate at £21 a ton, and the value of the tar at 35s. a ton, it will be seen that the value of the by-products recovered from this 760 H.P. installation are as follows :

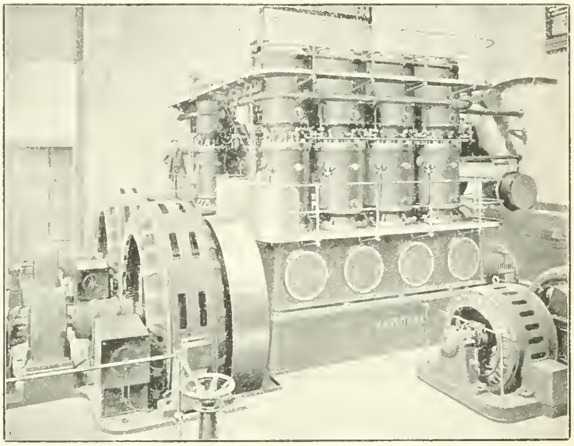


Fig. 3.—Two Sets, each 1,060 B.H.P., National Gas Engines. Eight Cylinder, Vertical Tandem Type.

Sulphate—29 tons, at £21 per ton	£609
Tar—75 tons, at 35s. per ton	131
Total per annum	£740

Engine Design.

Apart from the advantages of good turning effort from such a type of gas engine, as illustrated in Fig. 1, there is the further advantage in using comparatively small diameter pistons in relation to the total power developed. These pistons do not require to be water-cooled separately, thus freeing the gas engine from all complications arising from that source in consequence of the moving joints and rods containing water under pressure sufficient to maintain circulation, when the pistons are separately water-cooled.

The multi-cylinder gas engine is certainly the best type of gas engine for mill driving purposes. It possesses a degree of flexibility and speed regularity that make it especially suitable for driving textile machinery. Further, this excellent turning moment is obtained without resorting to an abnormally heavy flywheel. Starting-up is arranged for in a most satisfactory way by means of compressed air. The air is admitted to the lower cylinders by automatic cam-operated gear, so that the attendant has only to turn on the compressed air for a few seconds, and due to the number of pistons in operation, acceleration of the engine from rest to full working speed is carried out with speed and safety.

Fig. 2 illustrates a four-cylinder horizontal type of gas engine of 500 B.H.P. normal working load of the Premier Gas Engine Company's manufacture. Such a type of multi-cylinder engine is also suitable for mill driving purposes. The floor space taken up is rather more than by a vertical gas engine of equal power, and usually the revolving speed is a little less, although the piston speed may be the same in both cases. This is because the horizontal engine usually has the longer stroke. As a rule the horizontal type engine is more economical, due principally, but not entirely, to the shape of the combustion chamber. Overhauling and inspection are more easily carried out in the case of the horizontal engine than the vertical, by reason of all parts being on the floor level, and therefore more accessible.

Fig. 3 shows an installation of vertical tandem gas engines each 1,000 B.H.P., built by the National Gas Engine Company. These engines are eight cylinder type, of similar design to the one referred to at Hollins Mill. In this instance the "National" engines are directly coupled to electric generators for central station power purposes.

The National Company claim that an ideal scheme for the electrification of a textile mill is to generate power from a central gas engine. The lighting of the mill premises is obtained from the same engine. The time required to start up engines of this type is only a matter of a few moments, whereas a steam engine or turbine has to be warmed up gradually, which may take from 15 to 30 minutes for such a plant to get ready for the load, even when steam is available.

The Reliability Question.

Referring again to the question of "reliability," it ought not to be overlooked that during the past ten years a good deal of progress has been made in the construction of gas engines both in the design and materials used. Installations comprising gas engine sets of moderate power, say, up to 1,500 H.P. have been proved, under proper care, to be thoroughly reliable, in addition to being most economical types of prime movers. The stand-by losses with gas power installations in comparison with steam plant are very much less. In these days with the need for fuel economy, this question becomes one of national importance. It follows, therefore, that the claims of gas engines for textile mills, when the conditions are suitable, are entitled to have full consideration.

The Transmission and Distribution of Electricity in Textile Mills and Works.

By WALTER T. REYNOLDS.

In this article it is proposed to give a brief description of the various methods of transmitting electric energy in textile mills, dyeing, finishing and bleaching works.

Electricity was first used as an illuminant in the textile industry, the source of supply generally being a dynamo driven from the main mill engine, the ordinary carbon lamp being principally installed at 100-110 volts pressure. This method had the disadvantage that there was no illumination when the main engine stopped. A small pilot steam engine and dynamo were then introduced to which a pilot system of lighting was connected, these lights being placed in alley ways, passages, staircases, mechanic's shop, offices, engine and boiler houses, sizing room. The centre rows of lights in large rooms, positions which in the older mills often required artificial lights during the daytime, were also connected to the pilot circuit. The pilot circuit is provided in most modern mill installations whether the supply is obtained from private plant or from the local electrical supply authority.

Owing to the type of roof and ceiling construction, particularly in the weaving sheds, specially thick wood casings were sometimes employed, enabling the casings to be spanned from beam to beam, excepting where near to driving belts.

In some mills an open system of wiring was installed, no casing being used, but the wires and cables run on cleats. Such a method is not a common one in the ordinary textile mill, however, owing to the want of mechanical protection and of appearance. The whitewash brush plays considerable havoc with installations of this type and they cannot be recommended, except in special situations.

It was not very long before steel conduit was brought out, and it quickly became very popular as a method of enclosing wiring in mills, on account of the facility in erection and the reduction still further of fire risk. The close joint light gauge conduit, with socket accessories, was extensively used, and was certainly economical as regards the cost of installing.

This system of conduit was, however, soon superseded by the heavy gauge screwed system, which provided adequate mechanical protection, greater rigidity, and satisfactory metallic continuity. The wood, cased distribution boards were also replaced by iron-cased boards, ceiling roses and switches mounted upon iron boxes, and the entire wiring system made metallically continuous. This type of installation is the one most generally favoured at the present time.

Various other metallic systems have been introduced for lighting installations, and have been installed in textile mills, such systems as the "Stannos" tinned copper sheath system, the "Mavor Coulson" armoured cable system, the "Henley" wiring lead alloy sheath, the "Kalkos" tubing system. These lend themselves to the employment of the concentric conductor method of wiring, the sheathing (or in the case of the "Henley" an uninsulated copper taping) being used as the negative or return conductor. Such concentric conductor system can only generally be used on a private supply or on the public A.C. supply in conjunction with double wound transformers. It is not the intention to discuss the merits or disadvantages of these various schemes of wiring in this article.

Referring to the type of lamps, a few mills in the earliest days were equipped with arc lamps, which the incandescent electric lamp soon superseded, the latter in its turn giving premier place to the metallic filament one-watt type. Half-watt lamps are also being installed in certain situations, especially when the pressure has been transformed down to 100-110 volts on alternating current supplies. This latest type of lamp is useful where general rather than concentrated lighting is required. Arranging the lights on the "staggered" principle, as with some high pressure gas installations, the smaller half-watt lamps may be found adaptable even for spinning frame lighting. Considerable use is now being made of the one watt 100 watt lamp. Special reflectors designed to increase illuminating efficiency have been manufactured in recent years, though not used in textile mills as they might with advantage be. They are more expensive than ordinary enamelled iron, the type most generally provided. Efficient illumination is absolutely essential if production is to be best quality in maximum quantity, and more attention should be paid to the employment of good reflectors or shades.

The systems dealt with so far have been direct current (or single-phase alternating), but the advent of electric driving in the textile industry brought about the adoption of the three phase alternating current system. This caused a further modification in the transmission and distribution scheme for lighting. The balancing of the load across the three phases had to be considered as well as the question of guarding against induction losses in the metal covering or enclosing ducts of cables. Several schemes have been put into practice in cases where the source of supply has been a private one—most commonly a turbo-alternator at 400 to 500 volts. One method is to provide a three-phase transformer to transform down to pressures below 220 volts. The lower 100-110 volts pressure always gives the additional advantage of more economical maintenance, especially in regard to lamp renewals, though the initial outlay may be somewhat higher due to the larger capacity cables necessary.

Another method of distribution is to use three single-phase transformers instead of three phase, balancing the load as nearly as possible between them, which is likely to occasion smaller capacity sub-main circuits but more of them with correspondingly more distribution boards; the circuits are all double pole in the usual way. Another method which may commend itself in certain instances is to distribute to distribution board positions at the power pressure, and there fix small local transformers, each provided with a controlling switch, which may be fitted inside the case of the transformer with an external operating handle, to enable the transformer to be switched off locally when not in use.

If the installation is large, the sub-main circuits from the main board could be run four pole to section distributing fuseboards, from which double pole circuits would be run to the branch distribution boards, the balancing being carried out then on the section boards. In this arrangement the full power pressure is brought to the section boards. The connections to the neutral bus-bar can be made by links instead of fuses on the section boards.

Before leaving the subject of lighting, it is necessary to refer to the installations in the bleaching, dyeing and finishing branch of the textile industry. These present a difficult problem owing to the damp conditions and to the chemicals used in certain departments. In works of this nature, generally, various open wiring systems are employed. Vulcanised rubber standard conductors on porcelain cleats have been extensively installed, bitumen sheathed rubber conductors, vulcanised bitumen solid filled cables or lead covered conductors, in conjunction with watertight lamp fittings and watertight switches and apparatus in the wet or damp or chemical portions of the works. More recently "cab tyre" or solid rubber sheath cables have come much into favour, in conjunction with the patent "U Seal" fittings specially designed for this system by Mr. J. C. White. These fittings—switches, lampholders, ceiling roses, junction boxes—are arranged so that after the connections are made they can be sealed up with a semi-fluid compound poured into the sealing cups, this preventing moisture from creeping up the wires. In some special cases pure lead-covered cables are essential, and these can be sealed up by the "U Seal" fittings. The lamp fittings are often the china acid-proof well-glass type with sealing cable inlets, and these are separately suspended by suitable chain or wire rope. Special colour-matching arc lamps are much used now for matching colours only, not for general illumination, and have proved very satisfactory for this purpose.

POWER TRANSMISSION.

Attention is now directed to the power transmission and distribution in the spinning and weaving and the ordinary textile mills. Electric driving in textile mills was adopted much later than lighting and with it the three-phase supply was introduced, as previously mentioned. The method of the transmission and distribution depends upon the horsepower of the motors, and also upon whether group or individual driving is used. The earlier installations were group drive, but later individual driving for spinning frames, mules, looms was taken up. In addition to this some progressive mills have provided electric cooking kitchens in their canteens, where well-cooked ample meals can be supplied at an amazingly low cost. In comparison with lighting installations very heavy currents are required to be transmitted and distributed, the motors ranging from the small loom motor up to 300 h.p. and even higher than that. The point to be always borne in mind by the contractor is that, if protected by tubing or other metallic covering, the three cables must always be enclosed together and never separately, and more than one case has occurred where ignorance of this caused trouble through excessive heating of tubing or armouring as well as waste of energy. Heavy gauge screwed conduit has been used on many power installations, particularly for small sizes of cable, and in such cases it is advisable to give a twist to the cables every two or three feet to alter their relative positions in the conduits. This compelled the use of extra large tubes and consequently considerable expense in erection, and three-core armoured cables were found to be more serviceable, and are now chiefly installed for distributing circuits.

The main switchboard is generally arranged with oil circuit breakers controlling the feeder circuits to be taken therefrom. A separate feeder cable is usually run to each motor which exceeds a load of 100 amperes per phase, approximately 60-70 b.h.p. according to the voltage of the circuit. Smaller motors are fed from distributing power fuseboards, which are connected by feeder cables to the feeder switches, or outgoing switches as they are often termed, on the main board. The type of feeder and motor cables to be used depends upon the load, distance and local conditions. If run outside, paper insulated lead covered, double steel tape armoured, served and compounded overall three-core cables are used for loads not exceeding 400 amperes, and either two three-core in parallel or single-core cables, as mentioned previously for the main low tension cables, for loads exceeding that. For inside fixing, provided the run is sufficiently long to warrant it and for currents above 100 amperes, paper insulated three-core cables are employed, but single wire armoured left bare, instead of armoured served and compounded.

With regard to the connections between the control gear and the motors, generally two three-core cables are required (or six single-core if large motors). Care should be taken in determining the size of cable to the rotors of slip ring motors, as the rotor currents vary with different makes of machine and may be very much heavier than the stator current. If the motor is provided with short circuiting and brush lifting device, the rotor cables are often the same size as the stator cables, as they are only in circuit for the short period of time taken in starting up. When the short circuiting and brush lifting gear is not provided the rotor cables are in continuous circuit, and must consequently be the correct size to continuously carry the full rotor current. It is therefore advisable to ascertain what these rotor currents are and find out if brush lifting devices are fitted before deciding the capacity of the rotor cables.

The oil breakers controlling the slip ring motors have generally been interlocked mechanically with the starting rheostats, but some makers are now providing terminals on the motors to allow of electrical interlock, and small wires either in conduit or armoured type will require to be run for this.

The control gear makers now provide special cable glands on their apparatus if required for the connection of armoured cables, or special conduit inlets and outlets for conduit work. The contractor often wonders why similar arrangements are not provided on the motors and standardised, instead of only being fitted in exceptional cases. The efficient bonding and earthing of the apparatus and motor cases and the cable conduit or armouring is then assured. As it is, earth wires have to be used generally to join up the various parts, and there is always the danger of these being broken, or the attendant later on disconnecting and omitting to replace them. Serious accidents have occurred owing to this. The finished and workmanlike appearance of the proper metallic continuity method is well worth the small extra cost, not to speak of the safety factor. Contractors perhaps have not given sufficient voice to the requirements of their particular branch of the industry and in long-suffering silence have made the best of the materials manufactured to standard. How frequently cable terminals of apparatus are ridiculously small and awkward to get at; large cables expected to be squeezed into quite inadequate spaces, and worked round too short bends. Economy is often carried well beyond reasonable limits.

Reference must be made to the distribution schemes as effected by the individual driving of spinning frames and looms. The motors for the former are usually placed at the wall end of the frames and distribution boards are fixed on the walls in convenient positions. Several boards are required, and sometimes the feeder cable is looped through from one to the other. Alternatively power section-boards may be fixed and the feeder cable connected thereto. The branch feeders or sub-mains are then run to each distribution board from the section-board.

For the individual loom drive the standard voltage is 200 volts and special distributing systems are necessary, as the sub-feeder circuits and the branch circuits have usually, along with the branch distribution boards, to be in trenches in the floor. The type of distribution board employed has been the porcelain cartridge fuse pattern, the well known Siemens "Zed" or some similar pattern. The porcelain bases consist of one or two blocks containing generally six fuses to each block, the bus-bars being in the centre in channels, and arranged to facilitate the connection of the sub-feeder cables. The whole is fitted into a special iron floor box. The sub-feeder cables are the standard rubber insulated single core carried in conduit, and the branch circuits are generally 3/20s. S.W.G. also in conduit. One floor fuseboard is provided for every four loom motors (for every two, in the case of an odd row), and the branch circuits are run out from the boxes to the loom switches, which are placed on the floor and are operated by a handle on the loom. From the switches the branch wires are continued to the motors. Generally two circuits are brought out together from each side of the distribution board in one-inch conduit to a conduit box, where they divide, in $\frac{3}{4}$-in. conduit, one to the left and the other to the right to the respective looms. These branch conduits are also sunk in the floor.

Another system that has been installed is the bare copper bar sub-feeder system. Bare copper strips are run on suitable insulators in the trenches, together with an earthing cable, instead of the cables in conduit. The end connections to the section-boards can be made with either three-core armoured cable or single-core cables in tubing. From the section-boards the feeder cables are run to the weaving shed panel, and this is connected to a 200-volt transformer fixed near the panel. The transformer is fed from a switch on the main low tension switchboard if motors are used in other parts of the mill for spinning, or other processes.

In some branches of the textile industry the three-phase supply, for certain machines for which very large speed variations are required, is converted to three-wire direct current, say, 400-200 volts, a special panel being provided for this on the main switchboards, from which three-wire feeders are run, either conduit or armoured cable, to T.P. fuseboards, and thence branch circuits to the special controllers and motors.

Electricity Supply in Dundee Textile Mills.

By C. LAMB.

PREVIOUS to the year 1909 the entire textile factories of the city of Dundee were driven by reciprocating engines, with the exception of 200 to 300 H.P., which was only used for driving small isolated machines, the power being obtained, with one exception, from the Corporation Generating Station at 400 volts, direct current supply. Up to this time many of the manufacturers had been replacing their steam plant, especially boilers, and in a few cases new engines were installed. One firm about this time, however, laid down a 700 kw. turbo-alternator, generating a 3-phase supply for driving part of their works. After careful consideration of reports which had been submitted from time to time by Mr. H. Richardson, General Manager of the Corporation Electricity Supply Department, the Town Council decided to erect an up-to-date station at the Stannergate, within a few hundred feet of the River Tay. The generating station was completed in July, 1909, ready to supply textile works with current at 6,600 volts, 3-phase, 50 cycles.

Slow Progress at First.

Notwithstanding the fact that 60,000 H.P. is required for driving the textile factories in Dundee, very slow progress was made till 1912, and at that time not one factory was completely driven, although electric driving had demonstrated itself far beyond the trial period. The manufacturers in Dundee were very slow to move, and at the above time only some 3,000 H.P. of motors was being used to drive textile machinery. Between the years 1913 and 1915, after many discussions concerning the advantages of electric driving of textile machinery, and the fact that the Corporation were supplying power at an average cost of 0·45d. per unit for bulk supply consumers less 5 per cent. when the power factor was up to 0·8d., caused a large number of mills to change over totally or partially to electric driving. The total horse-power which was installed and running by the end of December, 1915, was approximately 12,281 H.P., of these approximately 68 per cent. is driven by power obtained from the Corporation mains.

These figures show that progress is steadily being made, although even now some owners consider it advisable to wait until their friends and competitors have carried out the experimenting.

Recent Progress.

During the war period no extensions were carried out, owing to the Government restrictions, although permits were granted in special cases and motors were installed of approximately 110 H.P.

Early in 1919 it was obvious that millowners were gaining confidence in electric driving, as a number of enquiries were being made regarding the capital expenditure and running costs, the figures being based, in practically every case, on the assumption that power would be taken from the Corporation mains. A serious set-back arose at this period, when a number of manufacturers who had applied to the Corporation for power were informed that, until extensions were carried out no new connections could be given, as the power station was already overloaded owing to the fact that all available power had been taken up during the war by local engineering and shipbuilding industries. Again, much valuable time was lost after the General Manager of the Electricity Department had reported and submitted his proposed extensions scheme, before the Council authorised the work to be carried out.

Notwithstanding the delay and the uncertainty as to when the new plant will be put into operation, a number of manufacturers have placed the orders for their plant, and from enquiries the Corporation expect a demand of 2,435 H.P. as soon as they are in a position to meet the load. From other information it is expected that during the next two or three years an additional 9,000 H.P. will be installed in textile mills. The total horse-power then installed will be equal to 21,156 H.P. or approximately 11 per cent. of the total horse-power required for driving the textile works in the city. No new textile works have been laid down in Dundee since the introduction of electric driving has enabled an up-to-date lay-out being installed, except one calender works, and several small extensions for special machinery.

Engineering Difficulties of Conversion.

Many engineering difficulties were encountered during the change-over period from mechanical to electric driving. In one case the only place available for laying down the sub-station and works power switchboard was the engine room, where two large horizontal engines with their pumps, piping, &c., occupied nearly the entire floor space. To enable a clearance to be made a temporary sub-station had to be erected between the two engines to allow a supply to be given for three motors of 100 H.P. each, erected in temporary positions. When this was done the small engine was removed, and the foundations cut down and rebuilt in parts to allow the floor being altered to a suitable level. During the alterations tons of masonry had to be handled, and a number of iron stanchions pinned up and under-built.

After the alterations were completed the permanent sub-station was built, and the electric gear fitted ready for the first section, which was erected temporarily, to be re-erected to complete the sub-station which was carried out during the week-end.

In another case, two small engines, which were driving vertical shafts and gearing, had to be removed. To enable the work to be carried out the sub-station of 500 kw. was erected in a store, and the motors fixed inside the spinning flats. The engines, vertical shafting, and gearing were then removed, and new shafting, couplings, pulleys and floors erected inside the driving alley. During the holiday week the sub-station gear and power switchboard were refitted into one of the engine rooms, the motors changed to the new floors in the alley way, and the shaft coupled up to the extension lengths.

In the case of the few private installations installed, new positions for the power houses were found in the works, and the plant erected and completed ready for driving the motors. Shafting difficulties, however, were met in many cases, but were got over by fixing the motors in temporary positions during alterations. It would be unfair to pass over without mention that great credit is due to the managers and their engineers for the careful manner in which they prepared their schemes and carried out the plans, as in no case were any of the works shut down beyond the prescribed holiday period.

Group Driving in General Use.

Group driving has been carried out in Dundee in every case, except in one factory, where individual driving is installed for looms. In calendering works where large mangles are in use, the general rule has been to instal separate motors up to 80 h.p. for individual machines. The general method adopted in carrying out the installations can be divided into two sections

- (*a*) Motors connected individually to a main panel on the power switchboard.
- (*b*) Motors group-connected to main panels on the power switchboard through distribution fuse-boxes erected at various parts of the works.

Although in the first case the initial cost of the installation is higher, it has been found preferable, due to the fact that the running costs of every section or department can be recorded by fixing watt meters on the main panels of the switchboard.

The principal driving methods in practice are, direct-coupled and belt or rope drive, although in connection with the smaller size motors, both chain and gearing is in use. The direct-coupled method of driving calls for a higher speed in line shafting, but any difficulty in this way is overcome by altering the main pulleys on the line shaft. In several installations it is a question whether the motors have been placed in the best positions, and sufficient consideration given to the various drives, to enable the transmission losses to be cut down to a minimum. On the other hand, in many cases, the want of space and the fact that extensive alterations in the lay-out of the machinery and shafting would require to be carried out, have induced many of the mill-owners to drive the main line shafts from the original driven end.

In the majority of cases three-phase transformers are installed, whilst in the others three single-phase transformers are installed, the standard voltage in all cases, on the secondary side, being 440 volts. The motors are all of the induction type, and in nearly every case above 20 h.p. are slip-ring fitted with brush-lifting and short-circuiting device, totally enclosed and ventilated, or semi enclosed with expanded metal covers. The load curves of the textile mills are generally very good, with an average power factor of 0·8, but where calendering work is the principal item, the load is a variable one, with a power factor of 0·55 to 0·75. Two examples of load curves are given in Figs. 1 and 2, the first from a spinning textile mill, and the second from a combined spinning and weaving mill.

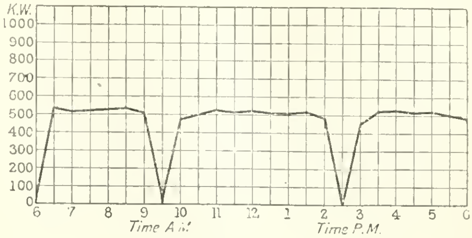


Fig. 1.

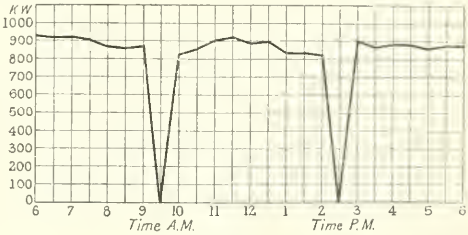


Fig. 2.

Should the Electric Drive be Adopted ?

In Dundee the question has arisen, time and again, when the management have been faced with the problems of replacing their steam plant, whether new engine and boilers should be laid down, or a complete change over to an electric

Tests on Various Jute Textile Machines.

Machine.	Type of drive.	B.H.P. running light.	B.H.P loaded.	Conditions of test
Jute opening	Belt	1·69	2·96	Feed-table 25" wide, allows at times for 7 % overload.
Jute softening	Belt	4·13	10·03	......
Jute breaker............	...	...	9·54	Running.
Card	Belt	4·29	11·24	Starting up loaded.
Jute finishing	...	...	5·03	Running.
Card	Belt	3·16	11·18	Started up loaded.
Jute three-head drawing frame	Belt	1·67	3·67	Delivery at 150 ft. per minute.
Jute roving frame, 2 machines	Belt	3·35	6·10	56 spindles per machine, bobbins 10" long by 5" wide, full.
Cop winding frame ...	Belt	...	8·63	Speed of machine spindle 920 revs. per min. Spindles per frame, 96. Weft, 8½-9 lb. per spindle. 11 spindles per horse.
Ball winding............	Belt	2.69	5·73	Speed of machine, 500 revs. per min. 80 balls running 4 tiers.
Spinning frame	Belt	...	3·57 to 3·96	Speed of machine, 2,700 revs. per min. 54 spindles. Bobbins 10" by 5". 10 lb. weft. 13·6 spindles per B.H.P.
Jute dressing	Belt	...	1·61	Beam ⅔ full, 18 yds. per minute.
			3·21	Beam ⅔ full, double motion.
			4·30	Beam full, double motion.
Looms	...	...	0·70	47" reed space, 140 pickers per min.
			0·76	53" ,, 140 ,,
			0·83	56" ,, 130 ,,
			0·98	66" ,, 126 ,,
			1·93	106" ,, 114 ,,
Cropping Machine Belt	...	...	3 0	96" length, speed 300 revs.

Figures for Individual Driven Looms.

Size of Loom.	h.p. of Motor.	Revs.	Picks.	Reeds.	Starting kw.	Running kw.
18″	¾-1	960	132	42	2·0	0·4
20″	¾-1	960	130	54	2·5	0·5
18″	¾-1	960	136	42	2·2	0·4
18″	¾-1	960	138	42	2·4	0·5
18″	1½	725	117	80	3·6	0·6
20″	¾-1	960	128	60	2·5	0·65
20″	¾-1	960	130	54	2·3	0·55
20″	¾-1	960	138	54	2·25	0·45
20″	¾-1	960	130	60	2·4	0·7
20″	¾-1	960	132	54	2·0	0·35

drive made. Difference of opinion still exists, and in some cases one is told that certain mills, which are driven by triple-expansion Corliss valve engines with high pressure steam, can beat any up-to-date electric-driven plant on costs. However, actual figures of the costs in the first case are difficult to obtain, as the management carefully camouflage the different points when the questions are put to them, which in one sense they cannot be blamed for. Figures have, however, been given in some cases, but when they have been analysed, unfortunately they mean nothing, as invariably some of the most important items have been left out. Regarding electric driving, however, the proof speaks for itself, as in no case where alterations have taken place in Dundee for the past number of years, has anything but electric driving been carried out. The question whether one should instal a turbine plant and generate one's own power, or obtain a supply direct from the Corporation mains, very seldom crops up in Dundee, as in nearly all cases the supply has been taken or arranged to be taken from the supply mains. Unfortunately, as already stated, the Corporation have not been in a position since 1915 to add any new power connections to their mains, but every endeavour is now being made to meet the present demand. Hints have, however, been given that some textile manufacturers are arranging to put down their own plant in the event of not being able to get connected to the supply mains at an early date.

In conclusion, it may be mentioned that so obvious is the certainty of electric driving of the jute factories and other works in Dundee, that the general manager of the Corporation Electricity Supply Department, after very careful consideration, has recommended his Council to consider the possibility of using water power from the Highlands for the immediate supply of the necessary 15,000 kw. now needed and the supply of the 50,000 kw. which will ultimately be required. The question of water *v.* steam will shortly be decided by Mr. Richardson and the extensions will then be rapidly proceeded with.

Application of Electricity to Textile Mills in India.

By JOHN KNOWLES M.I.Mech.E.

In response to the Tata Hydro-Electric Power Supply Company's circular announcing their ability to supply electric power to textile mills in the Island of Bombay, the writer's firm, Messrs. Bradbury & Company, mill agents and engineers, Bombay, applied for the supply of about 6,500 h.p. for the conversion of six cotton spinning and weaving mills (then under their agency) from mechanical driving to electric driving, viz. :—

1. The new City of Bombay Manufacturing Company, Ltd., having 33,000 ring spinning spindles.
2. The Sun Mills Company, Ltd., having 28,000 ring and mule spindles.
3. The Jehanghir Wadia Mills Company, Ltd. (incorporated with the Colaba Land Mill Compay), having 15,600 ring spindles.
4. The Colaba Land and Mill Company, Ltd., having 28,000 mule and ring spindles and 750 looms.
5. The Bradbury Mills Company, Ltd., having 30,000 mule and ring spindles and 550 looms.
6. The New Great Eastern S. and W. Company, Ltd., having 42,000 mule and ring spindles and 1,250 loms.

The original steam power plants at five of the above mills were of the ordinary horizontal side-by-side Corliss compound condensing type. A vertical triple expansion was employed at the Sun Mills Company, Ltd., the average indicated horse power of each mill being :

The New City of Bombay Mill Company	890
The Sun Mill Company	750
The Jehanghir Wadia Mill Company	450
The Colaba Land and Mill Company	1,100
The Bradbury Mill Company	850
The New Great Eastern S. & W. Company	1,450
Total	5,400

The several line shafts were driven in the usual manner from the rope fly wheels of the engines to the various line shafts passing through rope alleys, but in the case of the New Great Eastern S. and W. mill the "drive" was by a spur wheel bolted to the arms of the weight fly wheel of the engine, which geared into two second motion pinion wheels, and thence by bevil tooth wheels to line shafts on the ground and first floors of the mill. The weaving department cross line shafts were in all three cases driven by bevil tooth wheels.

As all the mills were at that time under time contracts for delivery of their manufactured goods, it was imperative to give weighty consideration to measures that would tend to minimise stoppages of the machinery during the period of installing the electric plant. The writer and his partners concluded that this would be facilitated if the respective mill company provided their own motors and installed them with their own staff. They, therefore, requested the Tata Hydro-Electric Power Supply Company to quote them a special rate for the supply of electric current only, which the company kindly agreed to do at annas 0·55 per unit, as against annas 0·5 per unit, when the Tata Company supply the motors and install them. Messrs. Bradbury & Company were very gratified at this concession which enabled them to purchase motors of special design and to instal them without much interference with the usual daily operation of the mills.

As the engineering departments at all the mills were under the writer's management, he took in hand the designing of the "lay-out" at the various mills, and also prepared the plans for motor towers, iron staircases, foundations for motors and toothed reduction gearing fixings. In so doing he had to pay due regard to the following circumstances and requirements :—

1. In deference to the views of a large body of the shareholders as to the successful working of the Tata Hydro-Electric Company's scheme, by reason of the possible failure of rain causing a shortage of water, the writer and his colleagues deemed it desirable to retain the original steam power plant at each mill until the reliability of the Tata scheme had been firmly established and to arrange all the electric drives so as to make it easy to bring the original steam power plant into action without delay if necessary.

2. The vital necessity of keeping the mills in daily operation.

3. In view of the speed of all line shaft being under 290 R.P.M., it necessitates the use of motors of moderate speed in order to minimise the necessity of changing the belt pulleys on the line shafts and the expense in time and money incidental to their removal and replacement. In the case of line shafts where no alteration in speed was permissible, and where a reduction in speed was necessary by the use of gearing to toothed gearing was held to be more reliable than rope pulleys, which increase the friction losses and introduces greater possibilities of stoppages owing the their frequent breakage and slackness.

The installations were carried out on the above lines with great success, and continue to give every satisfaction, especially in respect of the toothed gearing reduction sets supplied by the "Citroen" Gear Company, which work smoothly and with a minimum of friction losses as is shown by the fact that more looms per h.p. of the drive are driven than where rope pulley speed reduction is installed.

The Electrician.
FRIDAY, MARCH 5th, 1920.
Price ONE SHILLING. By Post 1s. 1d. Ann. Sub.: U.K. 52.s. Abroad 54s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

Electrification and the Textile Industry.

This issue of THE ELECTRICIAN is the second that has been devoted to a consideration of the application of the electric drive to the operation of textile machinery. The first of these issues appeared on November 17, 1911. Since that time much has happened. There has been a great European war, bringing with it not only an unprecedented demand for textile goods, but an increasing difficulty in obtaining the raw material to make these goods, and a consequent ever upward movement of both cost and selling prices. That war has been followed by a state of affairs which industrially is very much like war without the fighting. There is still the same difficulty in getting raw material, the same demand for the finished product, and the same upward movement in cost and selling price. And the textile industry is booming. This has, of course, connoted the increasing employment of the electric drive not only because of its inherent advantages, but because it was the only possible form of drive millowners could use during the war to make extensions most of them found necessary. In this way the electric drive received an advertisement, which, as is usual when a sound thing is advertised, has done it a great deal of good.

THE ELECTRIC DRIVE SUPREME.

This, indeed, is the one outstanding feature about the information which we give in this issue—that electricity is the best form of motive power to use in a textile factory.

We do not, however, wish it to be inferred that the battle of the drives is won or that textile manufacturers are throwing out steam turbines, reciprocating engines, or even gas engines wholesale to make room for electrical equipment. This is far from being the case, as Mr. ICKRINGILL shows in his article. But where new mills are erected or extensions are necessary the arguments in favour of the electric drive receive first consideration. This in itself is a notable advance since the time when we published our first textile issue. The same applies when it comes to making a decision between taking a supply from the public mains and putting down steam raising plant or gas engines in the mill itself in conjunction, in both cases, with electric motors on the textile machines. In 1910 opinion was much divided on this point. Many textile manufacturers and electrical engineers, too, for that matter, thought that there were advantages in making the mill self-contained. That view has changed. As Mr. W. BROWNING justly points out, the job of the textile manufacturer is to achieve the highest production of textile goods that he can compass, and the more his mind is kept to that and the less it is drawn away to other subjects, the better both for himself and the organisation he controls. In short, in this age of specialisation it is better to buy power than to generate. In arriving at this solution there are many interesting financial and engineering questions which must be studied, and these receive consideration in the articles published in this issue. We have already referred to Mr. ICKRINGILL's article and to that written by Mr. BROWNING. We may also mention those by Mr. REYNOLDS on the question of the transmission and distribution of electrical energy within the mill, and by Mr. DOW on the equally important question of illumination. All these articles bring our information on the subject up to date and form a platform from which fresh journeys may be begun.

GENERAL TEXTILE PROBLEMS.

In an issue of this kind, however, it is well to take a broad view. And in considering the question of the electric drive in textile factories it is further important that the electrical engineer should consider the operations performed by the machines the motor has to drive and the conditions that these operations impose on the electrical equipment. The textile manufacturer's problem is to obtain articles of a certain kind of a definite quality and in as large a quantity as possible. The electric drive is a means to these ends, and must adapt itself accordingly.

In this connection we think that the article contributed by Messrs. MYERS and HANTON will be found especially valuable. They describe in detail the various processes through which the raw cotton has to pass on its way to become a finished product, and give an indication of the engineering factors required in these processes. It will, we hope, make the electrical engineer realise that the difficulties are not all on his side and lead to a flexibility in the treatment of the problem which it does not always receive.

THE IMPORTANT QUESTION OF SPEED.

From the electrical point of view the factor of chief importance in textile manufacture is that of speed. The speed of the loom must be kept constant under the continually varying load, due to the varying effort required to move the slay and the intermittent effort required to accelerate the picking motion and shuttle. This gives rise to a cyclic speed variation. But, more important than this is to keep the speed regular from minute to minute, for if this is not done production is lost.

The characteristics of a good drive then are a high-starting torque and a regular speed, a drive of such strength being provided as to prevent a large cyclical speed variation. This question of speed is of great importance in considering whether individual or group drive of looms should be used. To obtain material of the same quality the speed must be kept constant. This condition is very difficult to fulfil if the looms are grouped, as it is obviously necessary from time to time to stop one or more machines for doffing or cleaning, and this has an effect on the speed of the remainder.

THE GENERAL SITUATION.

But all these problems are simply stages in the way of how to deal best with the finished product. Increased production is the cry; how best to achieve that increase is another matter. At present there is no difficulty about selling textile goods, and there would be little difficulty in producing them if it were not for the shortage of raw material. Mr. FRANK NASMITH, in his article on the textile industry in the United States, deals with this phase of the subject and shows, among other things, how the increasing demand for motor car tyres, for which almost any price will be paid, may re-act adversely not only on the cost but on the amount of other textile goods. America is our rival in many ways, and not least in the cotton industry, so that Mr. NASMITH's comparisons of the conditions and methods employed in the two countries is matter of a kind from which the most interesting deductions can be drawn. For this country textiles are a key industry, a key the retention of which is of paramount importance. Electrical engineers should be the first to recognise this, for on it much of our future progress must depend.

Electricity Supply to the Bolton Textile Works.

By W. J. H. WOOD
(Borough Electrical Engineer, Bolton)

Considerable progress is being made in the Bolton area of supply in driving textile mills electrically; in fact, while in 1910 the textile load connected to the mains was negligible, to-day it represents about 50 per cent. of our output, and the inquiries and applications we are receiving from textile mills for electrical energy are numerous. Until quite recently the progress made in the use of electrical energy in textile works has been very slow, and almost every electrical power supply engineer in Lancashire—the centre of the cotton industry of the world—knows only too well the difficulties he has had to overcome and the prejudice against the so-called new-fangled ideas he has had to break down.

It has taken a considerable amount of time and argument to convince the cotton spinner that, although he may be an expert on the production of yarn, the electrical power supply engineer specialises in the production of power. His factory or power station is equipped with efficient machinery for producing power and delivering this in the form of electrical energy at the manufacturers' works at a reasonable price, comparing favourably with the cost involved in producing power with a comparatively small private plant. The manufacturer naturally considers the matter entirely from the commercial point of view, and to him the larger question of saving the nation's coal—the direct result of centralisation of power production—is perhaps of secondary consideration, because it interests him more to know whether he can purchase power at a lower cost than he can produce it at himself.

The strides that are being made to-day in Lancashire in the adoption of electricity for textile mill driving, prove that it pays the manufacturer to buy power. It must be admitted that this is to some extent due to the present high price of coal and increased cartage rates which affect the individual user to a greater extent than the central electricity supply authority, because although the price of coal has equally increased to both, in the majority of cases the actual percentage increased price per unit of electricity is less than the increased price per ton of coal, especially taking into account the cost of cartage, which seriously affects the cost per ton of coal delivered to the manufacturer, whereas in the case of the power station this charge does not apply, because as a rule the coal used is delivered straight from the railway trucks into the bunker.

There are other advantages which influence the manufacturer towards buying power, and one is that the energy he requires for operating his machinery is always available when required. The thousand and one difficulties one comes up against in connection with power producing plant, the difficulty at times of obtaining coal, the trouble of obtaining efficient and reliable labour, &c., do not interest the purchaser. He pays the electricity supply authority to provide him with power, and it is up to the power station people to see that he has it.

Then there is the question of capital outlay on the power-producing equipment of a textile mill consisting of boilers, engine, chimney, cooling water reservoir, also the usual auxiliary plant and buildings, &c., which is considerably higher than the cost of installing motors and electrical equipment, consequently the annual capital charges are less in the case of the electrically-driven mill. The fact that the space which would be taken up by the buildings for housing the power plant, the reservoir, &c., could be used for installing productive machinery, and the earning capacity of the site increased proportionately must also not be overlooked. It is also much easier to deal with extensions in the case of an electrically-driven mill. These can be carried out when and where required without interfering with existing plant and the production. Take the case where it suits the owners to build and equip half or a portion of the works—in other words, to spread the capital expenditure over several years and to build in sections according to the demand for their production. With electrical driving this is quite simple and only means the installation of additional motors as required, whereas with a steam-driven mill it is quite another matter, and means additional boilers and engine power, unless, of course, provision has been made at the commencement by installing engine power of sufficient capacity for the ultimate requirements of the works. To do so is not only uneconomical but entails capital expenditure which for a time would be unproductive. There is also the question of increased production which is obtained from textile mills electrically driven off the public supply due to more constant speed. The actual gain in production depends so much upon the conditions prevailing at each individual works that it is an uncertain quantity, varying from 1 to 6 per cent. in some cases. The greatest advantage from electrical driving is found in a mill where electrical energy replaces a more or less obsolete engine or an engine running overloaded. In this case the engine can be relieved of part of its load by installing an electric motor for driving, say, one floor, and preferably the top floor of the mill. Then, as it is found necessary to take more load off the engine, additional motors are installed and eventually the whole mill is electrically driven. Instead of the whole of the expenditure coming at once, it is thus spread over a period, and the mill can be modernised without stopping its production.

As against the steam-driven mill there is also the case of installing a private electrical generating plant, but where an efficient public supply of electricity is available and energy can be purchased at a reasonable cost, it would be even more economical to retain steam driving than for a mill owner to install his own private electrical generating plant. One of the difficulties the power supply engineer is up against in electrical driving in textile mills is the question of mill heating. When the steam power has been replaced by electrical energy, the manufacturer has still to retain part of his steam-raising plant to heat the mill and consequently he does not obtain the fullest advantage.

It is necessary, therefore, that power supply engineers and electrical manufacturers should devise some means of electrically heating mills. It is, perhaps, interesting to note that a mill in the Bolton area is at present being equipped with a special design of electrical heaters as an experiment, and if successful it should considerably assist the progress that is being made in electrically driving textile mills. It will be of the greatest advantage to the electricity supply undertakings, because it will be a means of improving the load factor of the supply for textile mills which to-day does not exceed 28 per cent. In fact, if the prices charged for electrical energy for textile mill driving are to be reduced, the load factor of a mill load will have to be improved, and this can only be done by increasing the number of running hours, preferably by working two or even three shifts or by electrically heating the mills. This latter is chiefly required at night or during the period the machinery is not running.

With regard to the charges for electrical energy, it is necessary that some more or less uniform scale of charges should be adopted by the electricity supply undertakings supplying the textile area, and a scale of charges agreed upon sufficiently simple for the average mill owner to understand. He wants to be told in simple language what he is to pay, because, as a rule, he has not the time or the inclination to solve conundrums such as are put to him in many cases.

The Electrical Driving of Cotton Spinning Mills.*

By V. MALLALIEU.

As yet electrical driving has made less progress in the cotton industry than in many others—engineering, for example—no doubt because the cotton mill can be more efficiently driven by mechanical transmission direct from an engine than can, say, a general engineering works.

In the early days electricity was regarded more as a means of transmitting power between a private steam engine and the machinery to be driven than as a form of energy to be purchased like coal. Electrical transmission schemes of this type show to most advantage as against mechanical means of transmission when one or more of the following conditions obtain: (1) The machinery is scattered; (2) the various machines are operated intermittently and not simultaneously; (3) speed regulation of individual machines is required.

In many cases scattered mills have been provided with electric transmission. Many old mills comprise a number of small buildings covering a comparatively large area of ground, and were originally provided with complicated mechanical driving systems, which absorbed much of the power in friction. In such cases an electrical transmission system is justified, both as regards fuel economy and steady driving. With electrical driving a scattered mill may be made as efficient as a compact mill.

Individual driving offers certain general advantages. In the special case of the ring frame, however, an important additional advantage arises from the facility for speed regulation offered by the electric motor. With mechanical driving the frame cannot conveniently be run other than at one fixed speed through the process of spinning the cop, whereas the speed ought theoretically to be continually varied in a certain definite manner.

It is claimed on behalf of the variable speed drive that the average spindle speed can be considerably higher than with a constant speed drive, leading to a greater production; also, that since the yarn is spun and wound at constant tension its quality is improved, and the cop is more compactly wound. Against this we must reckon the high capital cost and maintenance expenses of the special variable speed equipment. Many mechanical speed-varying gears have been patented, but at present only the electrical method has found commercial application.

Under present conditions electrical driving, as far as the majority of Lancashire mills is concerned, is not regarded as a means of transmitting power from a private generating plant to the spinning machinery, but as the application of electrical power purchased in bulk from a large power station. The dominant but not the only factor is the cost as compared with a steam engine drive, which depends on local circumstances.

Take first the typical case of an existing mill where it is proposed to replace an uneconomical engine by motors. The comparison of annual power costs will be as follows:—

Steam Drive.	*Electric Drive.*
1. Coal purchased per annum, less allowance for heating mill.	1. Electricity to be purchased per annum.
2. Maintenance and insurance of engine boilers and their buildings, reservoir and chimney. Annual value of space and buildings which will be freed by removal of engine, boiler and reservoir.	2. Interest on capital cost of installing electrical plant, less price realised for engine, boiler and other material disposed of. Depreciation, maintenance and insurance of electrical plant.
3. Wages of engine driver and fireman.	3. Wages for attendance to motors.
4. Oil and stores, cost of water purchased, cost of ash removal.	4. Oils and stores.

So far as power costs are concerned, there is not much difference between steam driving and electrical driving, when electric power is obtained from an up-to-date power station. However, electric driving is justified on account of other advantages. Even supposing that the adoption of electrical driving increased power costs by 10 per cent., this increase in the total cost of production would be only 1 per cent. or less. On the other hand, the electric drive makes possible improvements in operating conditions which beneficially affect both the quantity and the quality of production, and this altogether outweighs the slight extra cost of power.

The two great advantages of electrical driving in this respect are smoothness of drive and greater convenience. Owing to the flexibility of electrical driving, the machinery of the mill can be arranged for most convenient operation; the drive is made to conform to the requirements of the machine, not the machine to the requirements of the drive. Further, electrical power can be accurately and easily measured, hence power consumption can be regularly checked, and faulty running detected before it becomes serious, and causes a stoppage. If a breakdown occurs it usually necessitates the shut-down of part of the mill only, and that only for a short time, as a faulty motor can be quickly repaired or replaced. However, a motor is certainly not more liable to breakdown than an engine.

Group Drive—Principle of Grouping.

When a spinning mill obtains its power by steam it is practically always driven by a single engine, because (1) one engine is less costly to install and more economical to run than two or more engines, and (2) a modern spinning mill is very compactly arranged and can be driven from one engine by means of simple mechanical transmissions without introducing undue frictional losses; such losses are far less than would be involved by running more than one engine.

With electrical driving the case is different. A large motor is not much more economical in power than a small one. Therefore, even in a compactly arranged mill, the total losses are usually less when a number of motors are installed than if the mill were driven by one large motor. The efficiencies of typical motors of various outputs are approximately, 93, 89 and 85 per cent. for motors of 1,000, 100 and 10 h.p. As regards running cost, a single large motor is usually at a disadvantage, its higher efficiency being outweighed by the extra mechanical transmission losses. A single motor drive often comes out cheaper than group drive as regards capital cost, especially in a compact mill, but this saving is not sufficient to justify the adoption of the single motor drive. A group drive is generally cheaper to install but less economical to run than individual drive.

The question of sub-division into groups depends upon (1) capital cost, (2) running cost, (3) steadiness of drive, (4) sectional working, (5) convenience in operation. Generally speaking, it is preferable to drive every line shaft from a separate motor, and as far as possible to run the line shaft at a sufficiently high speed for coupling the motor directly to it. If the line shaft is a long one, it is an advantage to couple the motor in the middle rather than at one end. Unfortunately, in many cases this would mean placing the motor in the middle of a dusty room, whereas, if the motor is at the end of the shaft it can be accommodated outside the workroom.

It is preferable to have large motors situated outside the workrooms with the view of keeping them clean and cool, and also keeping the workrooms cool. This condition can often be complied with by building a motor tower up the end of the mill, or, in the case of a shed, by building a motor alley at one end. Often, however, there is no option but to place the motors inside the workrooms; the motor should then be partitioned off and ventilated from the outside atmosphere, or, alternatively, the pipe ventilated type of motor should be used. Otherwise the cleanest situation available should be selected, and scrupulous attention paid to blowing the motor out thoroughly at frequent intervals.

Where individual drive is adopted, the motors must necessarily be inside the workrooms; they are, however, small machines generally placed in rows, and lend themselves well to pipe ventilation. This scheme has been adopted in most large individual drive installations in spinning mills. However, many ordinary standard squirrel cage protected motors have been installed in spinning rooms, and appear to operate satisfactorily; naturally more attention has to be paid to keeping them clean than in the case of the pipe ventilated motor.

It has already been stated that individual drive can only be justified if the specific advantages it offers more than compensate for its increased cost. These advantages include absolute smoothness of drive; sectional working without loss of power; breakdown troubles reduced to a minimum; convenience in operation unsurpassed; convenience in building, equipping or extending mill also unsurpassed.

Furthermore, individual driving offers: (1) The possibility of variable speed working (as already discussed in connection with ring spinning frames); (2) better and steadier illumination of the room, and freedom from moving shadows due to the absence of shafting and belts; (3) greater cleanliness; the atmosphere is not disturbed by belts, &c., and oil is not dropped from bearings and gear overhead; (4) reduced noise; (5) greater safety resulting from individual control of machines; (6) supervision is easier.

It will be seen that those machines lend themselves best to efficient electrical driving which have high driving shaft speeds.

The low speeds of machine shafts and line shafts prevailing in the past in mills have been a handicap to the electric drive, but the conditions are gradually improving in this respect. The cotton industry is older than the electric power industry, and hence the machinery used in cotton mills has been primarily designed for driving from line shafting; the designers of the machinery have accordingly aimed at low speeds in their driving pulleys comparable with the prevalent low speeds of the mill line shafts.

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* Abstract of Paper recently read by the author, who is on the commercial staff of the Metropolitan-Vickers Electrical Company, Ltd., before the Textile Institute.

On the other hand, the one essential condition for economical electrical driving is that the motor speed must be high. The progress of electrical driving is now having an influence in the direction of higher speeds in the mill, although the speeds of some machines are fixed by their fundamental design. Modern winding frames may be cited as a second example where higher speeds are being adopted. There is no doubt that as electrical driving, and particularly individual electrical driving, becomes more common in textile manufacture, the textile machine makers will endeavour to adapt their machines to high speed motor drive. Progress in such matters is always gradual, but if the present pre-eminent position in the cotton industry and in the cotton machinery industry is to be retained, it becomes necessary to look to the future and anticipate its needs. Electricity helps to meet those needs. If a broad view is taken of the trend of present day development, the conclusion inevitably driven home is that electricity is destined to be the motive power of the future.

The Electrification of a Large Scotch Works and Mill.

One of the largest worsted mills in Scotland is situated on the hills above Greenock and is owned by Messrs. Fleming, Reid & Company, Ltd. The whole processes of worsted spinning and knitting are carried out at these mills, and as the methods adopted for obtaining the power necessary to drive the various machines show considerable ingenuity, some details should prove interesting.

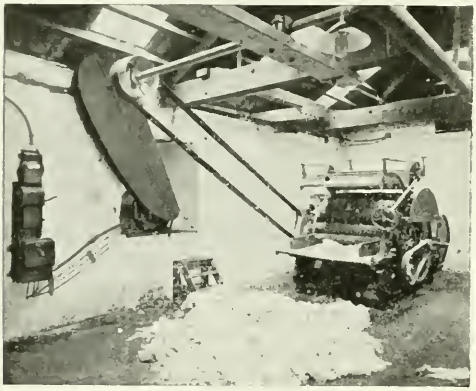

Fig. 1.—10 h.p. A.C. Motor Driving Breaking-up Machine Showing Starting Panel.

As far as possible, use is made of water power from the hills near at hand. The fall available is 180 ft., and the quantity is 24,000 cub. ft. per minute. This supply drives a water turbine of 580 h.p., which transmits the power by means of a rope races to the six storeys of the mill for operating the line shafting. A 125 kw. alternator is also driven by the water turbine through a rope drive, and supplies a large number of motors throughout the mill and its companion workshops. But, unfortunately, the hydraulic power available is not always sufficient to meet the above requirements. Consequently arrangements have been made to obtain power from the three-phase mains of the Corporation, which is synchronised with that from the generator, by means of switchgear mounted on a special panel.

Reference has already been made to the number of motors which are in use. The extent to which this mill is electrified will be realised by a consideration of the various processes involved in the translation of the raw material to knitted gloves, scarves, socks and the inevitable "jumper." After the initial sorting the raw material is passed through washing machines. In this room there is naturally a large amount of steam, and the 15 h.p. motor which drives these machines is therefore placed outside the room itself. After the washing is complete it is necessary to dry the wool. This operation is performed by a Petries' machine dryer, which is illustrated in Fig. 1. A good view is also obtained of the 10 h.p. motor which drives the 40-inch fan of the dryer. Hot air is forced through the dryer, and incidentally the wool is lifted to the top shelf of the machine, it then travels down the various shelves, and finally emerges in a thoroughly dry condition.

The next process is the well known one of carding, the function of the carding machine being to straighten the wool and arrange it so that it may more easily be manipulated for the further operations that are necessary. The feeding end of four of the sets of cards is clearly shown in Fig. 2. A good view is also obtainable of two of the four 15-h.p. motors which drive these machines. The motors run at 720 revs. per min., and drive the counter shaft at about 160 revs. per min. through sets of Whittall Belts, which, in conjunction with an electric motor, affords a most steady drive. This point will be clearly realised from the fact that the photograph from which the illustration has been produced was taken when the machines were running.

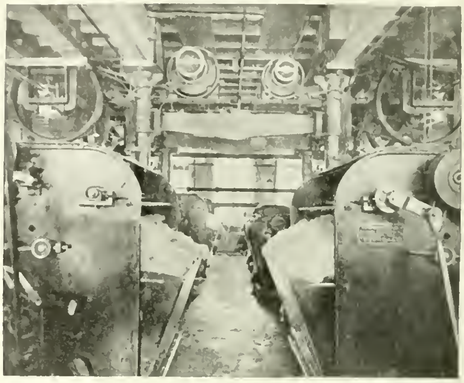

Fig. 2.—View in Carding Room Showing 15 h.p. Motors in Roof.

At the present time the machinery of the preparing and spinning rooms is driven by ropes direct from the large rope wheel of the turbine. When the yarn has been spun it is either dyed in the form of hanks or worked up in to various finished articles. If the former process is adopted, drying is obviously necessary.

Some idea of the output of the mill can be gained from the principal knitting room, a general view of which appears in Fig. 3. The shafts driving the various knitting machines are driven by a 25 h.p. motor in the right main corner of the room. In this room about 800 girls are employed on a large variety of different types of knitting machines. Electricity is used for driving not only the textile machines in this mill, but also for the various machines in the carpenters' and mechanics' shops, while electric goods hoists are used in the warehouse and forwarding departments.

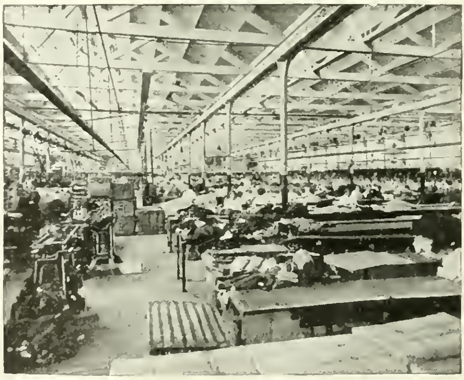

Fig. 3.—General View of Stocking Knitting Room.

The whole of the electrical equipment was supplied and installed by the General Electric Company, Ltd., of London, Witton, &c., through the agency of their Glasgow branch. In conclusion, our thanks are due to Messrs. Fleming, Reid & Company, Ltd., for their kind permission to take the photographs here produced, and also to publish the information contained in this article.

The Oerlikon Individual Drive for Ring Spinning and Twisting Frames.

It is necessary in the design of motors for driving ring spinning and twisting frames to arrange that the speed regulation shall fall within the conditions laid down by the operation of the frame itself. One of these is constancy of speed. In this point of view the three-phase induction motor has certain obvious advantages, but if a constant spindle speed is to be maintained throughout the cycle of spinning operations for instance the motor speed chosen must be appreciably lower than that which might be selected for the spinning of the main part of the coil. Now it is a well-known fact that most yarn breakages take place at the beginning of the formation of the bobbin and when spinning the coil points, while these breakages are much less in number during the formation of the cylindrical main part of the coil between the above-mentioned two larger zones. It will be seen then that the adoption of a constant spindle speed all through eliminates the possibility of utilising the ring frame to its fullest capacity.

The reason for the reduced number of yarn breakages during the spinning of the cylindical main part of the bobbin lies in the compensation of the yarn tensions which is obtained from the surplus yarn accumulated in the balloon. Yarn breakages only occur under these conditions when the tension on the yarn increases to such a value and lasts for so long a time that it cannot be compensated for by the simple alteration in the shape of the balloon. There is no doubt that the best method of minimising too great yarn tensions lies in the reduction of the spindle speed when required, and this method has been employed in conjunction with an interesting device by the Ateliers des Construction Oerlikon. By means of this arrangement it is claimed that the spindle speed can be regulated in the simplest possible manner to allow for less favourable yarn conditions, such as are present when forming the bobbin set and at the bobbin end. The device used by the Oerlikon Company for this purpose is shown in Fig. 1, and as will be seen it is exceedingly simple of design and robustly constructed. It is interlinked with and operated by the mechanisim provided for lifting the ring rail in such a manner that changes in the spindle speed are automatically carried out at the right moment. This is effected by increasing or decreasing the slip on the driving belt through a belt tightening pulley. This tightening only takes place during a period equal to about 10 per cent. of the total time of operation, and it is, therefore, claimed that no adverse influence on the life of the belt is experienced, while there is no loss of power during the slipping period, as the frame consumes less energy at the reduced speed, and the motor only takes current corresponding to the power requirements of the frame at the time.

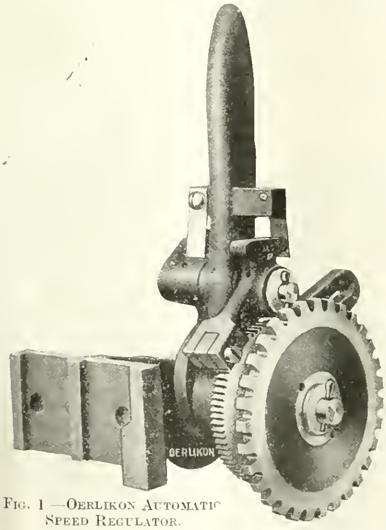

Fig. 1.—Oerlikon Automatic Speed Regulator.

The Ateliers des Construction Oerlikon are represented in this country by Mr. G. Wuthrich, Norfolk-street, London, W.C., who will be pleased to give any information upon this new drive or other textile specialities manufactured by the firm.

Textile Mill Electrification.

The rapid advances which are still being made in all branches of electrical engineering unfortunately render it impossible for a text book, whether it be on a general subject or deals with a particular phase of electrical progress, to keep closely up to date with what is being done. This is inevitable, though it is overcome to some extent by the enterprise of certain firms in publishing pamphlets which contain details of what is being done in one or other direction at or soon after the development occurs.

The publication, therefore, of a pamphlet on textile mill electrification by the General Electric Company is most opportune, and should give the mill owner who is faced with deciding for or against the complete electrification of his mill an amount of useful information which we hope will influence his decision in the right direction, and to the electrical engineer who has the task of persuading this gentleman a number of useful *points d'appui*, if they may be so called.

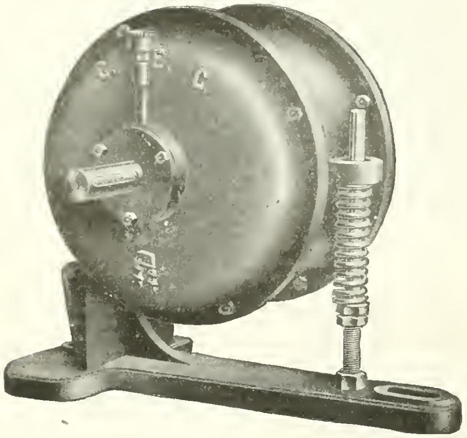

Fig. 1.—Typical G.E.C. Loom Motor of the Totally Enclosed Type on a Spring Base.

In this pamphlet the case for electric driving is presented in a most readable form, and the get-up is excellent, giving as it does a detailed account of the present state of the development of this form of drive and illustrating the text with a number of really wonderful photographs. It is, in short, a triumph of the art of publicity and the science of printing.

Turning to the contents of the pamphlet itself, after a brief introduction the general advantages of the application of electricity to textile work are rehearsed, each point as it arises being treated specifically in a detailed manner. The first, and perhaps the most important, question in considering this class of work is speed variation. As is well known, the old type of mechanical drive causes a great amount of damage to material due to irregular speed. To overcome this in the electric drive the three-phase induction motor is almost universally used, and is designed and installed so as to reduce speed variations to the lowest possible figure. The question of transmission losses is also of great importance in considering this problem, and we are not surprised to find that in the pamphlet the losses occurring with mechanical and electric drives are carefully discussed and tabulated. Other important advantages which the textile manufacturer will obtain by adopting the electric drive in his mill are adaptability, saving of floor space and head room, added safety, increased cleanliness, and, what is of great importance, decreased power consumption. These are all gone into; but in cases like this example is better than precept, and the General Electric Company have therefore done well in illustrating the pamphlet with a number of photographs, showing installations which they have actually carried out in textile mills. We give a selection of these herewith.

Dealing more particularly with the apparatus which has been designed by the General Electric Company for this class of work, we may call attention to the loom motor of the totally enclosed type fitted on a spring base which we illustrate in Fig. 1. The long running hours of motors driving textile machines make it desirable that a high efficiency should be reached, and to this end the motors are usually constructed with ball bearings, which not only lead to easy running, but give a more regular acceleration during starting than does the ordinary bearing. In addition, motors are designed with a low iron loss, special iron being employed for this purpose. As is well known, a textile mill is usually a very dusty place. This necessitates the employment of a totally-enclosed machine in order that fly and dust may be completely excluded in many cases. This total enclosure is, of course, not essential where the motors are placed in special corridors or motor rooms. The textile motor shown is manufactured in sizes of $\frac{1}{2}$, $\frac{3}{4}$ and 1 H.P. It is totally enclosed, and is mounted on a small base plate, operated at one end by a spring which allows the belt to be automatically tightened. The General Electric Company have also designed a special form of circuit-breaker for service when motors have to be switched directly on to the mains. The tripping is effected automatically by the expansion of a strip which becomes heated by the load current, so that excessive currents such as flow when a small induction motor is being started up, do not affect the breaker in time to trip it before the load has died down. It is considered the best practice to control each individual motor by a main switch, and for small loom motors no starter in the proper sense of the word is employed. A small triple-pole switch is employed for this purpose, the motor being switched direct on to the line. For this purpose a new type of switch enclosed in a cast-iron case and arranged to occupy the smallest space has been designed, while special starters and distribution boards for this class of work are also manufactured, and are described in the pages of the book.

Fig. 2. Circular Knitting Room lighted by Osram Lamps. (This photograph was taken by the light of the works.)

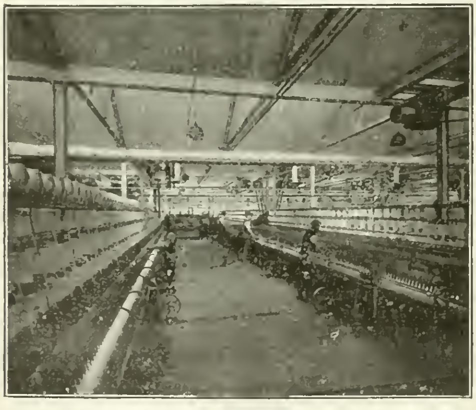

Fig. 3.—View of Weaving Shed, where each Machine is driven by One Motor, showing absence of Overhead Gear.

Fig. 4.—Typical View of Yorkshire Worsted Mill, showing Fly Frames driven by G.E.C. Motors.

This account gives a very inadequate idea of the useful information to be found in the pamphlet, and we therefore cannot do better than suggest that those interested in the subject should apply to Mr. H. Clifford Palmer, manager of the General Electric Company's publicity department, for a copy.

Variable Speed Motor for Textile Work.

An interesting design of motor, which is said to be particularly well adapted for giving a variable speed drive to ring frames, has recently been put on the market by Messrs. Wrights Motors, Ltd. The motor in question is of spherical shape with a short circuited stator, both the stator and the rotor being arranged so that they can revolve. The whole of the revolving parts are mounted on ball bearings. The shaft on which the rotor is mounted is hollow and on to it is keyed a hemispherical cup which covers, but does not touch, a portion of the approximately spherical shell of the stator. Fixed in some convenient manner to the frame of the machine is a projection with its axis at right angles to that of the rotor shaft. On this projection is pivoted a lever carrying two conical wheels which are covered with Ferodo or some other similar material. These wheels are geared together in such a manner that when one is rotated in one direction the other rotates in the opposite direction, and they are so mounted that they can be brought into contact with the surface of the spherical shell of the motor and with the surface of the cup on the rotor shaft respectively.

The operation of the device is as follows: At starting the rotor shaft is held stationary by the load, the stator begins to revolve round the rotor and so drives the first cone wheel. This transmits an opposite motion of rotation to the second cone wheel and thereby to the rotor shaft. A movement of a lever brings the first cone wheel into engagement with another part of the motor shell and the second cone wheel into an engagement with another part of the hemispherical cup, so causing the speed of the cup and shaft to be reduced or increased according to which way the lever is moved. A very small movement of this lever will result in considerable variation in the speed. This arrangement when fixed to the tin roller shaft of a spinning frame, allows, it is claimed, an automatic variation of the speed in accordance with the varying strains and stresses which go on during the process of spinning. Its application to this class of work has, indeed, been proved by careful tests, and we are told that the result is an increased production of cotton of from 10 to 12 per cent., after allowance has been made for reduction in the number of spindles due to the space taken up by the motor.

A Personal Explanation.

The following is a letter which has been sent by Mr. Godfrey C. Isaacs, Managing Director, to the shareholders of the Marconi's Wireless Telegraph Co., Ltd. :—

DEAR SIR (OR MADAM),

I would remind you that on the 31st July, 1918, at the General Meeting of the Company, the shareholders present, with one dissentient, passed a vote of confidence in me and declined to accept my resignation which I then offered following the verdict of the jury in the action which I had brought against Sir Charles Hobhouse for libel.

The case arose in consequence of a denial made in the House of Commons, and subsequently repeated in the Public Press, that on the occasion of a visit to Berlin of Sir Charles Hobhouse, accompanied by Sir Henry Norman, early in 1914, German firms had been invited to this country to start in competition with the Marconi Company. It was said that statements that I had made to this effect were malicious inventions.

You will remember that the action was tried in the summer of 1918 whilst the War was proceeding, and when there was consequently no possibility of my having access to Germany for the purpose of confirming these statements.

Since Peace was declared I have taken steps to obtain the necessary documentary evidence.

I do not here propose to place before you the whole of the evidence which I have thus secured, but will confine myself to contrasting letters written and signed by Sir Henry Norman and now available, with extracts from his evidence and statements in Parliament.

On March 19th, 1918, in his statement in the House of Commons relating to his visit, Sir Henry Norman said :—

> " I was merely a private individual."

In his evidence at the trial he was asked :—

> " *Q.* 3247. It is a small point, but would you have had any authority whatsoever to make such an offer ?"
>
> " *A.* Not the slightest in the world. My position was that of an unofficial person—a private citizen. I had no authority and position entitling me to make such an offer."

Contrast this statement in Parliament and this evidence on oath with the two letters he wrote on February 18th, 1914, to the Manager of the Telefunken Company and to Baron von Lepel respectively. I quote from these letters as follows :—

To the Telefunken Co. :—

> " . . . .
>
> " We are coming officially to have the advantage of seeing German institutions of national research, and I am sure that Mr. Hobhouse would greatly value the opportunity of seeing your admirable station at Nauen, and I myself should be more than glad to renew my very pleasant acquaintance with it and to hear of your latest long-distance triumphs."
>
> " . . . .

To Baron von Lepel :—

> " Dear Baron von Lepel,
>
> " Mr. Binyon has told me of your new and interesting work in Germany and given me your address. I shall be in Berlin on official business in connection with the National telegraphic research from the evening of the 26th, for four or five days, and if it is agreeable to you I should very much like to visit your laboratory and renew the pleasant acquaintance which you may remember began in Paris some time ago."

It will be observed that in both these letters he makes the definite statement that his visit is an official one.

A week after writing these letters, *i.e.*, February 26th, 1914, Mr. Hobhouse, as he then was, and Sir Henry Norman arrived in Berlin.

On March 2nd, 1914, they visited the Nauen Wireless Station.

On March 3rd they left Berlin.

The statements which I had made and which gave rise to his action were based originally upon a letter received from the Telefunken Company relating to the visit of these gentlemen from whom I quote the following :—

> " . . . .
>
> " After this conversation Sir Henry Norman naturally had gained the impression that there is no question of Telefunken as a competitor in England, and in the meantime has got into touch with Herr von Lepel. It is said that Sir Henry Norman has the intention of encouraging Herr von Lepel in founding an English Company and of putting him into touch with financial people for that purpose. . . .
>
> " P.S.—Mr. Hird knows further particulars."

Sir Henry Norman in the witness box stated on oath that there was no truth whatsoever in the statements contained in that letter.

The following, however, are the facts :—

On March 5th, 1914, two days after Sir Henry Norman had left Berlin, and probably therefore the day after the night of his arrival in London, he wrote to Baron von Lepel as follows :—

> " . . . .
>
> " With regard to Wireless I once more strongly urge you to hurry as much as possible in getting ready a set even of small power, say 1 kw. in actual communicating order in this country. Time is very important in this matter . . . .
>
> " P.S.—Binyon rang me up by telephone to-day and was very pleased to hear of my visit and my views. Please leave the Wireless in *my* hands."

A long correspondence ensued and continued until the outbreak of War. It consisted throughout of an endeavour on the part of Sir Henry Norman to induce Baron von Lepel to come to London and from an English Wireless Company conjointly with the Indo-European Telegraph Co., Ltd. (Mr. Stratford-Andrews), and Sir Henry Norman's friend (Mr. Basil Binyon),and to dissuade Baron von Lepel from forming a German Company which he was disposed to do. The correspondence shows that he was advising Baron von Lepel upon the figures connected with the proposed Company, the constitution of the Board of Directors, &c., and that he was himself contemplating becoming Chairman of the Board.

He wrote on the 20th June, 1914 :—

> " . . . .
>
> " I think it would, beyond question, be of the utmost value for you to have as Chairman a man whose name would command influence in the Wireless World—to say nothing of the value of his knowledge. Lord Desart is, of course, a man of the highest standing, but he would, as Chairman, be ornamental so far as Wireless is concerned. As regards myself, since you mention it, as I have not been asked I have not considered whether I am prepared to abandon my position of personal independence . . . . I hear some extraordinarily interesting news about the Marconi people and the Imperial stations—scientific news which interests *you* particularly. I will tell you when we meet. . . . .
>
> " P.S.—You should also have an arrangement beforehand regarding the Board of Directors—how many, their fees, &c. The Board should not be large—*klein aber gut!* *. It ought to be a very influential Board as its character and weight would have great influence in any dealings with the Government.
>
> " I think another really influential Member of Parliament from the conservative side would be of importance. Such an one could be found. And possibly another independent Wireless man of personal standing. I know such an one. Remember there are hundreds of people with titles, &c., in this country ready to go on any respectable Board, but they carry no weight. Possibly a man influential in shipping circles should be added.
>
> " I regard the constitution of your Board as, in your own interests, of the greatest possible importance.
>
> " It is possible you should consider the amalgamation with another great system—not Marconi, of course.
>
> " I don't see how you can settle all these matters without coming to London.
>
> " All next week I shall be in London, so please address me there if you write."

On the following day, the 21st June, he wrote again :—

> " . . . .
>
> " As regards my own position in the matter all I can say is that I should like to talk it over with you. . . . I will write to you again after I have seen Binyon, but I look forward to seeing you in London before long and having a decisive talk with you about your business prospects, and whether I shall have any direct relation to them or not."

On the 22nd June, the next day, Mr. Basil Binyon, Sir Henry Norman's friend, wrote to Baron von Lepel :—

> " . . . .
>
> " I am sorry that I was unable to write yesterday, but I had lunch with Sir Henry and then a long interview with the Indo-European, so that I was unable to find time to write to you. . . . He intimated to me perfectly clearly that he would seriously consider accepting the Chairmanship of our proposed Company, and this tip I have given to our friends so that I hope they will adopt it. . . . Sir Henry Norman appears satisfied with the scheme, and further evidence of this is given by the fact that he appears willing to join as Chairman, though this is, of course, subject to the other names of the Board. Sir Henry is very anxious to know when you will be coming to England."

In view of these letters I would ask you to read with attention some questions in the case of Isaacs *v.* Hobhouse put to Sir Henry Norman in Examination in Chief and the answers on oath which he gave :—

> " *Q.* 3229. Has your interest been a purely scientific or a commercial interest ?

---

* Translation, " small but good."

> "*A.* Absolutely always a scientific interest. Never under any circumstances a commercial interest.

In cross-examination :

> "*Q.* 3513. Have you at any stage or in any circumstances had anything to do with the promotion of commercial things ?
>
> "*A.* Never. I have most carefully kept apart from them.

In examination-in-chief :—

> "*Q.* 3242. During that time which you saw von Lepel, or at any other time, did you, as suggested in the German letter, which I dare say you remember, of the 21st July, approach von Lepel with the object of encouraging him to form an English company and to obtain for him financial assistance with this object ?
>
> "*A.* That is a question which cannot be answered by a simple 'yes' or 'no.' Von Lepel was engaged on what he believed, as all inventors believe about their inventions, to be an invention of very great value. He told me about it at that time and frequently afterwards. I encouraged him in the sense of offering him the opportunity of showing it to the experts of the British Services. As regards his commercial project which he spoke to me about, or wrote to me later, I neither encouraged him nor discouraged him, but I made it perfectly clear to him that I would have no commercial relations of any sort. That statement I can prove by a copy of a letter to him on that very point. . . .
>
> "*Q.* 3254. Did he in fact come over later for that purpose ?
>
> "*A.* Yes ; I placed my workshop at his disposal for that purpose, but telling him that no commercial friend of his must be present.
>
> "*Q.* 3255. You said that ?
>
> "*A.* I did. I have a letter to him to that effect."

At this time it would appear from the correspondence that Baron von Lepel had received an excellent offer from his German and Austrian friends for the formation of a German Company, and he so informed Sir Henry Norman.

Sir Henry Norman anxious to prevent this and to ensure the formation of an English Company, wrote on Sunday, 28th June, 1914, to Baron von Lepel :—

> " . . . .
>
> "If this happened, my own course would also be quite clear. I should move heaven and earth to compel the British Government to exercise its right under the Patent and Designs Act and take over all the patents it wanted for its Imperial stations and refer the Patent owners to the Treasury which would decide the sum to be paid for the use of them. They have under this Act of Parliament full power to do this and it would be the only way to defeat the monopoly in the public interest. If there is to be no competition, that will certainly be my line of action, *and it will succeed.* So long as there is competition between your Company and Marconi, for instance, the State will only have to pay fair commercial prices, but if there is to be a great world monopoly, then I take to the warpath in the interest of my country !
>
> "All these things you must carefully consider. A German Company for you for German interests I quite understand ; but my opinion, for what it may be worth, is that if you wish to do British work you must have your British Company first ; your German interests will not be less valuable, but rather they will be greater because of your British Company ; so I am naturally glad that you say you will not decide before you come to England again. . . ."

Was this letter, or was it not, intended to encourage Baron von Lepel to come over to this country to form a Company to compete with the Marconi Company ?

It will be remembered that Sir Henry Norman had always contended that his attitude towards the Imperial Contract for the construction of Wireless Stations was that it should not be given to the Marconi Company, or any other private Company, but that the Chain of Stations should be constructed by the State.

The following are further questions to him and his answers in Isaacs *v.* Hobhouse :—

> "*Q.* 3398 . . . .
>
> "*A.* Do you mean I thought the second best thing was that the State should employ some other Company rather than the Marconi ?
>
> "*Q.* 3399. That the State should employ another Company for the second three stations, if one was found more efficient ?
>
> "*A.* That the State should employ a Company, No ; that would have been contrary to my whole attitude.
>
> "*Q.* 3401. (Mr. Justice Darling) : What do you say that would have been ?
>
> "*A.* That would have been contrary to my whole attitude."

It is impossible to reconcile this evidence with the letters from which I have quoted above.

Having written his letter of 28th June it would appear as though Sir Henry Norman later had further reflected and was desirous of making quite sure of getting Baron von Lepel to London. He apparently conceived the idea of giving a Wireless dinner in Baron von Lepel's honour, and he on the same day wrote him the following post card :—

> "Can you tell me if you will *certainly* be in London on Tuesday, July 14th, as I wish to ask a number of Wireless men, official and others, to dinner. If not, between what dates ? Would you kindly *telegraph* me reply. . . . . ."

Baron von Lepel replied by telegram, and Sir Henry Norman fixed the dinner for Wednesday, July 15th, and on July 1st wrote to Baron von Lepel :—

> "I have your telegram. The dinner is for Wednesday, 15th. Don't fail, as you will meet all the leading Wireless men of this country, official and unofficial, if they are free to accept my invitation.
>
> " . . . .
>
> "I am getting up this dinner for *you—auf ihr ganz spezielles !* * If they all come, it will be a unique occasion. . . . I wish I could tell you about the new Marconi news—it would make you jump !"

In Isaacs *v.* Hobhouse, questions were put to Sir Henry Norman about this dinner, and I quote :—

> "*Q.* 3362. (Mr. Justice Darling) : "I thought I recognised the names. Many of these people came to the dinner ?
>
> "*A.* The dinner was given by me in honour of Mr. Louis Austin, the wireless expert of the United States Government, who happened to be passing through London. I asked him if he would like to meet representative Wireless men and he said he would much like to do so, and therefore as a courtesy to this very eminent Wireless man, I arranged this dinner party. I asked every Wireless expert I knew, representing every system, beginning with Mr. Marconi."

The dinner took place on the 15th July, 1914, and Baron von Lepel was present.

The next day, the 16th, Mr. F. Hird, the Manager of Siemens Brothers & Company, Woolwich, wrote to the Telefunken Company :

> "It may interest you to know that I had the honour to dine with Sir Henry Norman, M.P., yesterday evening. I enclose a card, from which you will see the guests who were present, and I shall be much obliged if you will return the same to me after perusal.
>
> "I had some conversation with Mr. Lepel and with others, and I rather conclude from one or two remarks that there may be some intention of providing financial support for Mr. Lepel, that Sir Henry Norman has interested himself in the matter, and that there is some possibility of Mr. Beit lending financial assistance.
>
> "Mr. Lepel told me that he expected to win his action against you in Germany in September, and counts upon damages of about £250,000, which does not appear to be very modest."

It is greatly to be regretted that Mr. Hird was quite unable to find his copy of this letter when he gave his evidence in Isaacs *v.* Hobhouse, and was unable to remember even having written it.

At the end of the month Germany declared War. The last letter that Sir Henry Norman wrote to Baron von Lepel bears no date, but is headed "Wednesday," and reads as follows :—

> "Dear Baron von Lepel,
>
> "I am wondering if you have been called to join your regiment !
>
> "I should like to know how you are getting on. I shall be at the House of Commons this afternoon from 5.30, if you are free and would send in a card to me.
>
> "P.S.—Mr. Stratford Andrews is coming to see me to-morrow."

There is considerable further correspondence from which I could quote, but I think I have set out at present sufficient for my purpose.

It will be remembered that Sir Henry Norman was a most important witness for the Plaintiff, Sir Charles Hobhouse. Had we not been at the time of the trial at War with Germany he would have been cross-examined upon his letters from which I have quoted, and it would have become manifest that he was doing his utmost to induce Baron von Lepel to come over here and take part in the formation of an English Company to do business with the British Government and compete with the Marconi Company. Equally, these letters would have established, contrary to his evidence, that his interest in Wireless was not purely scientific, as he had always represented, but that he was taking an active interest with Baron von Lepel in the formation of a Company, and was contemplating becoming its Chairman.

It will now, I think, be clear to the Shareholders that if the letters from which I have quoted had been forthcoming at the trial, a very different complexion would have been placed upon the evidence of Sir Henry Norman and Mr. Hird, and they could not fail to have had a very distinct effect upon the result.

I am, &c.,
GODFREY C. ISAACS,
Managing Director.

London, W.C.2.
Feb. 26th.

---

* Translation, "for your special honour."

Electricity Supply.

Barnstaple Corporation has appointed Mr. J. S. Highfield a consulting engineer to prepare a report upon the scheme of electricity extensions prepared by the borough electrical engineer, Mr. J. W. Hadfield.

Sunderland Corporation last week adopted the Electricity Committee's scheme for extensions of plant, &c., at a total estimated cost of £127,068, of which £117,723 is to be borrowed.

Leicester City Corporation has authorised the Tramway and Electricity Committee to apply to the Electricity Commissioners for sanction to erect a new generating station in Aylestone-road. For the completion and equipment of the station a sum of £600,000 will be required, but at first only two 10,000 kw. turbo-alternators will be installed. The consulting engineer is Mr. C. H. Wordingham.

Stoke-on-Trent Corporation has applied for sanction to borrow £50,000 for extensions of plant, &c., and £16,351 to cover excess expenditure up to the 31st March, 1919. The Council are recommended by the Finance and Electricity Committees to agree to the principle of the erection of an electricity supply station for the North-West Midlands area, on the lines suggested by Mr. J. H. Rider, subject to satisfactory arrangements being made with the Electricity Commissioners and the local authorities concerned in the supply area.

The accounts of Rotherham electricity department for the year ended March 31 show revenue £108,873, gross profit £20,514, and net profit £2,514, out of which £912 was paid for a report on electricity supply, and other amounts were devoted to provision of new services and meters, &c., leaving £601 to place to renewals fund. Income was equal to 1·06d. per unit sold (compared with 0·871d. in previous year), working expenses were 0·859d. (0·651d.), and capital charges 0·176d. (0·158d.). Units sold were 24,623,978.

In a report on the Aberdeen electricity undertaking Mr. John H. Rider has informed the Electricity Committee that it was not now essential that any scheme put forward for improving the supply of electricity in any district should include the formation of a Joint Electricity Authority. A satisfactory improvement might be made either by linking up, or by the development of, existing power stations. He believed it to be the intentions of the Commissioners to discourage extensions to local stations except it could be conclusively shown that the new plant would economically fit in with a future larger scheme. The distribution area of the Corporation could be extended from time to time as the demand for electrical energy warranted, by a special Order made by the Commissioners. Further, it was clear that the Corporation could not be compelled to extend its system, or to lay mains in any new locality, except on terms which would guarantee a minimum return of the outlay. The Committee has, therefore, agreed to extend the Dee Village Works. The question of utilising power-water from Loch Tummell in generating electricity has been dropped.

Electric Traction.

Mr. Frank C. Wilson has been elected chairman of the Liverpool Corporation Tramways Committee in succession to Ald. E. Russell Taylor, who resigned recently.

Southport Tramways Committee recommend the borrowing of over £41,000 for the purchase of the Southport Tramway Company's undertaking, the purchase of three "toast rack" cars, new machinery for and extension of the depot.

Birmingham Tramways Committee, being in urgent need of 3,000 tramway rails for the reconstruction of the Bordesley Green and Alum Rock-road, Nechells and Ladywood tramway routes, recently invited tenders. Only one tender was, however, received—viz., from the United States Steel Products Company—at £24 10s. per ton. While the Committee are adverse to placing the order abroad, under the present economic conditions, they feel they are faced with the alternative of holding up indefinitely the tramway repairs or of accepting the tender, and on Tuesday they recommended the Council to adopt the latter course. The recommendation was adopted.

Institution Notes.

Among the new fellows of the Royal Society recommended for election are the following: Dr. E. Frankland Armstrong, Sir Jagadis Chunder Bose, Dr. Arthur Price Chattock, Dr. C. G. Knott and Prof. F. A. Lindemann.

The Council of the Institution of Electrical Engineers have decided to cancel the suspension of the examination for Associate Membership, which will be imposed on all candidates not having passed one of the exempting examinations or submitted a satisfactory thesis, whose applications are received after Feb. 29, 1920. In the case of applicants who have attained the age of 35 the Council may, in their discretion, dispense with the examination or thesis.

Personal and Appointments.

Mr. Sidney Russ, D.Sc. has been appointed first incumbent of the Joel Chair of Physics, tenable at the Middlesex Hospital Medical School.

The Home Secretary has appointed Mr. R. E. Graves, C.B.E., to be Chief Inspector of Factories in succession to Sir Malcolm Robinson, C.B., I.S.O., who will retire on March 31.

Sir Francis Dent will retire from the position of general manager of the South Eastern and Chatham Railway on March 31, and from that date Mr. Percy C. Tempest will occupy the position of general manager in addition to his present appointment as chief engineer.

Miscellaneous.

The Eastern Telegraph Company announce that owing to the interruption of the lines of the British Pacific cable between Australia and Canada and the Commercial Pacific Cable Company's cable between the United States and the Far East, all traffic carried by those two routes will now have to pass over the Eastern Company's system, and consequently additional delay may be expected. The interruptions are expected to be of short duration.

A direct wireless telegraph service for commercial and general purposes was inaugurated on Monday between Great Britain and the United States. The service is being conducted jointly by the English Marconi Company and the Radio Corporation of America over a route operated entirely by them. Messages are accepted for New York, Greater New York and South America up to 4d. less per word than the existing cable charges. Messages are transmitted from the high power Marconi station at Carnarvon, and are received on the American side at Belmar, N.J.

All officers who commanded searchlight sections in France are requested to send their names and addresses to Major A. W. Mawby, O.B.E., R.E., 47, Penywern-road, Earl's Court, S.W.5. This request is not with a view to immediate re-mobilisation, but in order that he may furnish as complete a list as possible to Capt. K. M. Locke, M.C., who is organising an annual dinner of all anti-aircraft officers later in the year, at which searchlight officers will be welcome: and also to enable Major Mawby to keep a record for the purpose of a regular annual reunion dinner of overseas searchlight officers. The first overseas searchlight officers' dinner, to which Major Mawby invited all with whom he was able to get in touch, was held at the Trocadero Restaurant on the 30th ult.

A staff dinner of Messrs. Evershed & Vignoles, Ltd., was held at Pinoli's Restaurant on Feb. 26 to celebrate the 25th anniversary of the Company. Over 90 members of the staff participated, with Mr. Vignoles in the chair. The guests of the evening were Mr. Vignoles, Mr. Vines and Mr. Gregory, Directors of the Company. Considerable enthusiasm was displayed at this re-union after five years of war. Mr. Vignoles, in his reply to the toast of "Our Guests and the Firm" proposed by Mr. Shepherd, welcomed the members of the staff who had returned to the Firm after their period of service with the Forces. His remarks were much appreciated, and in an interesting speech he outlined the history of the firm. Mr. Vines also replied, and after other toasts had been honoured there was a very enjoyable concert.

Tenders Invited and Accepted.

Tenders are required by March 15 for the supply of electrical goods, &c., to the Cheshire County Asylum, Parkside, near Macclesfield. Forms of tender from the Clerk.

Clydebank Corporation require tenders by March 13 for electric wiring and fitting work in 160 houses to be erected at Kilbowie. Forms of tender, &c., from the Burgh Surveyor, Clydebank.

The Commissioners of H M Works, &c., require tenders by March 12, for 12 months' supplies of electrical accessories. Forms from the Controller of Stores, King Charles-street, Westminster, S.W.1.

Bedford Corporation electricity department invite tenders for year's supply of meters, H.T. and L.T. cables. Tenders to the Town Clerk, by noon, April 3.

Halifax Electricity and Tramways Committee invite tenders for supply and erection of a 10,000 kw. turbo-alternator with condenser. Specifications from the borough electrical engineer (Mr. W. M. Rogerson), and tenders by noon March 12 to the Town Clerk (Mr. Percy Saunders).

Belfast Electricity Committee invite tenders for various stores and materials, including mill furnishings, packing and asbestos goods, lubricating oils, tools, cables, wires, electrical accessories, lamps, carbons, troughing, &c. Forms of tender from the City electrical engineer, Mr. T. W. Bloxam, and tenders must be lodged at the office of the Town Clerk Mr. R. Meyer), City Hall, Belfast, by March 10.

Companies' Reports, &c.

The transfer books of the Telegraph Construction & Maintenance Company, Ltd., are closed from the 1st to the 11th inst. inclusive, preparatory to payment of dividend.

At an extraordinary general meeting of the General Electric Company, Ltd., on Monday the resolutions passed at the recent extraordinary general meeting approving of the readjustment of capital and alterations in the articles of association were confirmed.

The directors of the Direct Spanish Telegraph Company, Ltd., have decided to pay the following dividends for the year 1919, viz.: At rate of 10 per cent. per annum on the preference shares (less tax), and 5 per cent. with a bonus on the ordinary shares of 3 per cent. for the year (tax free), making 10 per cent. on the ordinary shares for the year, 2 per cent. having been paid on Oct. 1 last.

The Kensington & Knightsbridge Electric Lighting Company reports that during 1919 the number of houses and shops connected increased from 5,173 to 5,409 and the energy consuming devices from 17,178 kw. to 18,096 kw. The number of units sold was 4,627,529. The net profit was £13,529. Adding £543 from 1918 and deducting the interim dividends already paid, the balance is £8,073, out of which must be deducted the second half-year's dividend on the first preference and provision made for the dividend on the second preference shares, leaving £5,948. The board recommend payment of a dividend at rate of 9 per cent. per annum for the last half-year, making with the interim dividend 7 per cent. for the year on the ordinary shares, carrying forward £1,223.

LONDON SUPPLY COMPANIES.

Mr. Walter Leaf, who presided over the meeting of the ST. JAMES'S & PALL MALL ELECTRIC LIGHT COMPANY, said the past year's figures surpassed any reasonable hopes which they should have ventured to express a year ago. The revival of trade in the leading industries had been most striking, and in that revival the electrical industry had had its full share. Their main difficulty, especially in the later months, had been not to extend their output, but to cope with the fresh business which kept pouring in. In 1919 they sold 12,190,000 units, against 10,593,000 in 1918, and the revenue rose from £160,2[illegible]5 to £208,466. The increase in revenue was not due to any raising of price to the consumer. There was also a large increase in the cost of production, mainly in the price of coal. The cost of generation and distribution had risen from £95,105 in 1918 to £116,763. The growth of their business had involved large obligations in the extension of their Grove road station, and they had further pressing requirements. They were giving a supply in bulk to the Chelsea Company, and it was probable that before long they might be called upon to render assistance to other important undertakings. Fortunately they decided early last year upon a large extension of buildings and plant of the Central Company. Good progress had been made, but there had been delays in the delivery of the new 10,000 kw. set, on which they were dependent for next year's supply. The fresh demands had, however, made it essential that they should order another 10,000 kw. set, and push on with the new boiler house. They had decided to add to depreciation account the whole sum required to write down their securities to their market value, and for that purpose they had set aside £14,728. After making that large reserve, they had enough to justify them in raising the dividend from 10 per cent. to 12 per cent., the dividend of the year before the war. They hoped shortly to be able to announce a concession which would have the effect of reducing the cost of supply. Despite the fact that nearly 18 months had elapsed since hostilities ceased, times had remained difficult owing to the great demands upon manufacturers for reconstruction purposes.

Referring to the Electricity Supply Act, he said the conferences which one or other of their directors had with the directors of other London companies had led to the formation by the companies in the West End group, including the Charing Cross Company, of a small private limited company, with a capital of £50,000, for the purpose of drawing up a scheme for the electrical supply of London. That company, in which the St. James's had taken 729 shares of £1 each, was intended to form the nucleus of a general combination of all the London companies. There was a good prospect that it would succeed in that object, and would end by including all the companies, and the presentation of one common scheme. The municipal authorities also had a scheme of their own.

At the meeting of the WESTMINSTER ELECTRIC SUPPLY CORPORATION Mr. J. Browne Martin presided, in the absence (through illness) of Lord Downham. The chairman's speech stated that the receipts had increased by £76,000 and the expenses by £39,000. The coal supply had caused a great deal of anxiety during the year, and if they had not laid in very large stocks of coal during last summer they would not have been able to carry on. Coal had risen to an average price of 39s. per ton. 39,000 tons were burned for the supply to consumers, and the increase over last year had added about £12,000 to their expenses. During the last quarter an unexpected and very welcome increase in output occurred, owing largely to the removal of the restrictions on supply, so that the receipts during the last quarter of 1919 were the largest they had ever had in any similar period. After reviewing all the facts, the directors decided that the proposed increase of ½d. per unit on the lighting supply as from Jan. 1 should not be made. In recommending the raising of the dividend to the pre-war rate of 10 per cent., the directors believed that, while they had been careful of the interests of the shareholders, they had not neglected those of the consumer. The balance of the debentures had been repaid. After referring to the Electricity (Supply) Act, he said they had associated themselves with other London companies in putting forward a scheme for the supply of electricity to the London area, and their engineers were now preparing it. Finance, however, would be the great difficulty. When they considered that in London 42 per cent. of their total costs for generation and supply of electricity were due to capital charges, and that the construction of generating stations would be, at present prices, approximately from £25 to £30 per kilowatt, the cost of the erection of a large station, say, of 200,000 kw., would be some five or six millions, to which had to be added the cost of mains and transforming plant. They would readily see how important it was that the companies should utilise their existing resources to the largest possible extent. The companies supplying electricity within the London area had expended on their undertakings over 16 millions, and the average return on that capital for 1918 was 4·8 per cent. It must also not be forgotten that the London companies were the pioneers of electricity supply in this country, and that it was largely owing to their experimental work that the industry reached the stage of being the key industry of the country, especially during the war. The Westminster Company was the first in London to reduce the charges to the public for power and heating to a flat rate of 1d. per unit, and even now, when with increasing expenses they had found it necessary to increase the charge to 1½d. per unit, he believed they were lower than any other undertaking in the metropolis. They had in the station of the Central Electric Company at Grove-road a station that compared favourably with the best in the country. Orders had been placed for more generating machinery of a much larger size than they had hitherto used. He thought the Government would be well advised, considering the present condition of the finances of the country and the prevailing high taxation, to leave expensive schemes such as those outlined in the King's speech to private enterprise and existing undertakers.

Forty Years Ago.

(THE ELECTRICIAN, MARCH 6, 1880.)

AN EXPERIMENT ON INDUCTION.—At the last meeting of the Society of Telegraph Engineers, during the discussion of Mr. C. H. Wilson's paper "On Induction in Parallel Circuits," Mr. Willoughby Smith described a very interesting experiment he had made with a bladder of gutta percha, which well illustrated the electrical and other qualities of that material. . . . The superficial area of the bladder immersed was 203·6 square inches, its thickness 0·00065 of an inch, and its total weight 32 grains. The bladder contained 12 lb. 14 oz. of water, and had been suspended in air for eight days before it was immersed. The absolute electrical resistance of the 203·6 square inches was 1,487·6 megohms at the end of one minute's electrification, and of 10 minutes it was 4,1038 megohms. The absolute electrostatic capacity was 0·2266 microfarads. Its behaviour during the test was precisely the same as that of copper conductors insulated with gutta percha for telegraphic purposes when similarly placed. Mr. Smith is continuing the experiments with the view of determining a true unit for the electrical properties of gutta percha.

SIEMENS ELECTRIC LIGHT. The management of the British Museum have decided to permanently adopt the Siemens electric light for lighting the great Reading Room. The lamps have been provided with a glass tray hung under them to catch any sparks of red-hot carbon that may fall and prevent them from dropping on any books or papers underneath. The old polyhedral glass shades are also being superseded by globes of frosted glass.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics":—"The Cairo-Cape Flights"; "The New Avro"; and "Characteristics of Design Affecting Production, Operations and Maintenance of Aircraft," by Major Percy Bishop.

"The Cabinet Maker":—"Upholstering in Morocco and Imitation Leather"; "Silvered Bevelled Glass Supplies: Present Position"; and "The Furnishing of Aeroplane Coupés."

"Chemical Age":—"Progress of British Fine Chemical Industry"; Notes on recent Chemical Developments in the United States; and British Chemical Firms' New Capital Issues.

"The Fruit-Grower":—"Unification of Organisation—A Great Centrifugal Movement of the Day"; "White Rot Disease of Onions"; "National Fruit Growers' Federation."

"The Gas World" contains a special monthly section treating of the by-product coking industry; and detailed analysis of annual accounts of 18 important gas undertakings.

"Hardware Trade Journal":—"Foreign Markets for Dairy Machinery"; Special Metal Market Charts; and "Hints on the Erection of Bearings and Shafting."

"Ways and Means":—"America and the Economic Crisis," by Sir George Paish; "Linen and the Clothing Problem," by Alfred S. Moore; "The Menace of the Press," by The Editor; "Ca' Canny," by C. E. Hughes; and "The Situation in Hungary," by Alban Parker.

Prices of Metals, Chemicals, &c.

TUESDAY, March 2.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£127 0 0	—	£1 0 0
Electro Wirebars...	„	£130 0 0	—	1 0 0
H.C. wire basis......	per lb.	1s. $5\frac{5}{16}$d.	—	⅛d.
Sheet	„	1s. $6\frac{9}{16}$d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	„	1s. $9\frac{5}{16}$d.	—	⅛d.
Brass 60/40—				
Rod, basis	„	1s. 0⅞d.	—	⅛d.
Sheet, basis	„	1s. 5½d.	1d.	—
Wire, basis	„	1s. 4½d.		—
Iron—				
Cleveland Warrants	per ton	£9 2 6	—	—
Galvanised steel wire, basis 8 SWG	„	£43 0 0	—	—
Lead Pig—				
English	„	£53 10 0	£0 5 0	—
Foreign or colonial	„	52 0 0	—	£0 5 0
Tin—Ingot	„	403 10 0	—	7 0 0
Wire, basis	per lb.	0 5 0	—	1d.

Salammoniac.—Per cwt. 95s. and 90s.

Sulphur (Flowers).—Per ton £22.

„ (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £48.

Boric Acid (Crystals).—Per ton. £74.

Carbon Bisulphide.—Per ton £56.

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate—Per lb. 5½d.

Rubber.—Para fine, 2s. 7d.; plantation 1st. latex 2s. 7d. per lb.

Shellac.—T.N. Orange, 825s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,182. [Vol. LXXXIV. No. 11.] FRIDAY, MARCH 12, 1920. PRICE ONE SHILLING. *By Post, 1s. 1d. Abroad, 1s. 2d.*

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Notes.

Empire Wireless Network.

WE have received particulars of proposals made by Marconi's Wireless Telegraph Company to the Imperial Wireless Sub-Committee for the establishment of "a network of wireless communications to serve the needs of the whole British Empire." The scheme provides for the establishment of trunk and branch routes, permitting communication between this country and any part of the Empire, and also for communication between any part of the Empire and ships at sea, between latitudes 60 N and 50 S. Twenty-six main trunk stations (five of them in this country) would be built, and a staff amounting to some thousands, all of whom would be British subjects, would be required. The white staff would be members of a reserve naval or military force which on mobilisation would remain at their posts. The Marconi Company offers at its own cost to construct, maintain and operate the whole of the network, and to pay to each Government in whose territory the stations are situated 25 per cent. of the stations' net profits, while at the end of the 30 years, the stations would become, if desired, the property of the Governments concerned, free of cost. Further, the stations may be taken over at any time by paying for them the value at which they then stand in the Company's books, plus any sum which may have been expended on the creation of the services, and by paying to the Company 10 per cent. of the gross receipts for the remainder of the period of 30 years. The Governments will also have the right to take over the stations during any period of hostilities. The offer is subject to the conditions that the Governments concerned shall issue all the requisite licences for a period of 30 years, grant every facility for acquiring the sites, and lay the necessary telegraph and telephone lines; that the Company reserve the right to extend the system to foreign countries, provided that Imperial traffic shall invariably have precedence over foreign traffic and that the Governments shall secure the allocation of suitable international wave lengths to the stations in the network, and shall see that stations belonging to other companies shall not be allowed to use unscientific apparatus or be granted wave-lengths which would interfere with the working of the Imperial network. Technical details are not gone into at any great length, but it is stated that all the trunk and feeder stations should employ continuous waves in connection with the high-frequency alternator and the valve. Valve apparatus capable of dealing with an output of 100 kw. has been developed and it is expected that a corresponding aerial power of 75 kw. will be obtained. An aerial current of 300 amperes is within the bounds of possibility, and the problem of eliminating the higher harmonics produced by the valve has also been successfully attacked. FRANKLIN'S system of receiving aerials would be used. This is a development of the BELLINI-TOSI direction finder by which signals can be received within close limits from any one direction, and no other. A number of receiving stations can be located on one site, as the various systems may be crossed owing to the use of small frame aerials. No balancing aerials are required. It is found that this type of aerial reduces atmospheric disturbance to a minimum. It may be ungracious to look a gift horse in the mouth, but nevertheless we hope that the Wireless Committee will examine these proposals most carefully. While we are willing to pay the Marconi Company a just tribute for the work they have done in the development of wireless telegraphy, both technically and commercially, we cannot forget certain facts which go to show that they are determined, if possible, to establish a world-wide monopoly in this form of communication. To allow the establishment of such a monopoly would, we feel, be unfortunate in a growing science like wireless telegraphy. What we want is an inter-play of ideas and methods from which we can obtain a system which shall be the best for all purposes. There is still much to be done before we arrive at that condition of things, and freedom of operation is therefore greatly to be desired.

The Fifth Electricity Commissioner.

THE mystery surrounding the appointment of the fifth and last Electricity Commissioner has been dispersed by the appointment of Sir HENRY HAWARD, Comptroller of the London County Council. In commenting upon the appointment of the other four Commissioners we expressed the hope that the remaining vacancy would be filled by the appointment of a financial expert. While Sir HENRY HAWARD, who has been connected for some years with all the many and various financial operations of the London County Council may be said to answer that description, he was not the sort of expert we had in mind. His financial knowledge must have been mainly of a municipal kind, and, except for the tramways undertaking his electrical experience has been mainly concerned with the granting of loans to the municipally owned undertakings in the County of London. We would sooner have seen someone with a practical knowledge of the money and stock and share markets in this position, in other words a financier from the city whose business it has been to make money out of money. Sir Harry Haward's duties will include the negotiation of financial matters with those who know little and care less about municipal methods and, though we hope he will be successful in his new position, that success will be in spite of, and not because of, his previous experience. We suppose the real difficulty in obtaining a man from the City has been the question of salary. The Government do not yet realise that if they want a good man they must pay for him, and that a salary of £3,000 is not very attractive to the big-wigs of Throgmorton-street and its purlieus.

The Registration of Engineers.

News, it is said, travels fast but nevertheless it sometimes takes a long while to become disseminated through the individual intelligences of the body politic. In December last we called attention to a Bill which the Institution of Civil Engineers proposed to introduce in the present session of Parliament for powers to prepare and keep a register of engineers. Our comment was that such application should preferably be made jointly by the three leading engineering institutions, and that whoever kept the register membership of the Institution of Civil Engineers should not be a necessary preliminary to registration. We thought the matter of some interest and were rather disappointed to receive no communications agreeing with or travesting our conclusions. But the seed we sowed seems to have borne some fruit. Within the last week or two the matter has been discussed editorially and in the correspondence columns of several technical journals, and we are gratified that the general opinion agrees with our own. Meanwhile the Bill has been dropped, so that further discussion and comment is redundant. But we hope when this question of registration is raised again, as it is sure to be, it will be raised in a more definite form and with more weight behind it. The time has passed when the engineer can be satisfied with a purely professional status, he must now have a political status as well, and he must take his proper position in the national economy in a way he is not doing at present.

The Remuneration of Technical Work.

Men possessing scientific and technical attainments have for so long been badly paid in this country that the inadequate remuneration of our brain workers has come to be considered as much one of our national customs as attendance at football matches or a financial interest in the performance of race horses. The fault did not however entirely lay with the capitalist and employer, but was not a little due to the scientist himself. For he was so interested in his work that his salary was a secondary object, and he thus became, though probably quite unconsciously, a sort of blackleg. The increased cost of living and the rising wages of the labouring classes have called attention to the low rate of remuneration of scientific workers and brought about a determination on the part of those concerned that something must be done. What the present position is so far as the chemical industry is concerned is evident from a report published by the Institute of Chemistry. Some months ago the Council issued a circular asking Fellows and Associates to supply particulars regarding their salaries, prospects and general conditions of employment. About 1,000 replies were received, and the results are very interesting. The average rate of pay of all branches at 25 years is £310 per annum. In the industry the rate is somewhat higher. Against this the manual worker in the shipbuilding earns about £250 per annum, in engineering about £235, and in building about £225. Members of these three classes have presumably been educated by the State at little cost to themselves or their parents, while the chemist has received an expensive education which brings him a very little better return. It would be interesting to learn what the corresponding figures among electrical engineers are, and we suggest to the Institution that they might add to their activities by undertaking such an enquiry. Owing to the large number of members holding commercial or semi-commercial positions, which are, of course, better paid the replies will not be strictly comparable, but by dividing the returns into groups depending on the class of work performed some informative results would doubtless be obtained. This matter in its broadest aspect has been brought to the attention of the Government by a deputation from the British Medical Association and the British Science Guild to the Lord President of the Council. Sympathetic consideration was promised. Scientific and technical workers who desire that their remuneration should bear a closer relation to the nature of their work would do well however not to place too much reliance on this sympathy, but to trust to their own efforts either alone or in combination. "The returns," says the Institute of Chemistry report already referred to, "indicate less discontent than might reasonably have been anticipated." That is not the spirit which obtains redress of wrongs.

Combined Meetings.

The joint meeting of the Institution of Electrical Engineers the Royal Society of Medicine and the Rontgen Society held recently to discuss the application of electricity to X-Ray work set a precedent which we shall hope to see followed on other occasions. The papers read were perhaps not all that could be desired as regards matter and presentation, and the subsequent speakers rather failed to come to grips with the difficulties which the discussion was supposed to lighten. It really ought not to have been hard to do so. On the one hand we have the electro-therapeutist and the radiologist who find that the electrical apparatus which they now use is not so suitable as it might be. On the other is the electrical engineer engaged in the manufacture of apparatus for this class of work and anxious to know how the equipment is going to be used so that he may arrange his design accordingly. Each can give the other useful information if they are careful to stick to facts and to avoid the pitfall of speculation. This idea of holding joint meetings with users of electrical appliances is one that we should like to see extended. Every profession and trade that uses electricity in some form or other has its institution or association. Why not joint meetings with them to discuss the difficulties that arise in applying the electric drive to their particular class of work? The advantages of this course are before us when we publish our periodical special issues, and we have no reason to be other than satisfied at the success of our attempts in this direction. But a joint discussion would be even more successful, and we feel certain equally beneficial to both parties.

Acoustical Engineering.

As knowledge develops new fields for specialisation continuously present themselves. "Illuminating Engineering," which deals with the applications of light, is now well established. "Thermal Engineering," involving practical applications of heat energy, is less well defined, although there already exists a body dealing specifically with heat in relation to ventilation, and one occasionally hears the phrase "heating expert," or even heating engineer. But there is another field, that of "Acoustical Engineering," which cannot be said to have been at all fully developed as yet. Although sound shares with heat and light a place in physics courses at most colleges and institutions, the subject is apt to get side-tracked, even on the theoretical side. Its many practical aspects have received far less study. Among these is the problem of the acoustic properties of buildings, a much neglected problem. Makers of musical instruments in this country rarely call science to their aid. The whole question of sound-signalling offers a wide field for research. No doubt the inherent difficulties of devising a satisfactory standard and system of measurement for sound partly account for this. A few months ago we drew attention to the able work of Mr. A. G. Webster, in the United States, in this field. Meantime experience with submarine-locating devices and other forms of listening apparatus, has led to considerable progress in this work. Practical acoustics seems to be receiving more attention in the States. We notice that Prof. V. Karapetoff, of Cornell University, has recently been emphasing the importance of "Acoustical Engineering," referring particularly to the perfecting of audible signalling devices for office use, whereby the head of departments in a large building can be readily summoned together.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

We publish the first of a series of articles by Mr. H. H. Broughton on "Electric Winding Engines and Mine Hoists" (p. 286). In the present series of articles it is proposed to deal with cylindrical drum winders operating in inclined and compound shafts, the efficiency of these machines being illustrated by reference to existing winders of various types.

We give an account of the three Papers on "Electricity in Connection with X-Ray Work" read before a joint meeting of the Institution of Electrical Engineers, the Royal Society of Medicine and the Röntgen Society, and of the discussion which took place on them (p. 289).

We conclude our account of the Birmingham Section of the British Industries Fair, and give a short account of the exhibits of electrical interest at the Crystal Palace Fair (p. 291).

We give an account of discussions which took place in Birmingham and Manchester on Mr. J. Shepherd's Paper on "Failures of Turbo-Generators and Suggestions for Improvements," which was read recently before the Institution of Electrical Engineers (p. 292).

Our serial article on Recent Heating and Cooking Apparatus appears on p. 294.

The electrical equipment of the Naval and Military Club, where half-watt lamps have recently been installed, is described on p. 295. This was the first club in London to be fitted with electric light.

An account of the annual dinner of the Institution of Electrical Engineers, which took place on Thursday, March 4th, is given on page 296.

Our leading article discusses a Paper read at the North-Western Centre of the Institution of Electrical Engineers by Lieut.-Col. Aldous and Mr. A. E. Scanes on "Electric Power Supply in the Rhine Valley" (p. 299).

On p. 301 we publish an article on the Imperial Wireless Controversy.

A description is given of Messrs. Reyrolle & Company's new telephone cable dividing boxes on p. 301.

A new loud speaking telephone manufactured by the Western Electric Company is described on p. 300.

Arrangements for the Week.

FRIDAY, March 12th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers: "Absorption of Gases in the Electric Discharge Tube," by Mr. F. W. Newman, B.Sc.; "A New Directional Hot Wire Anemometer," by Mr. J. S. G. Thomas, M.Sc., and Exhibit of a New Microbalance, by Dr. Hans Pettersson.

UNIVERSITY COLLEGE (LONDON) ENGINEERING SOCIETY.

5.30 p.m. In the Botanical Theatre, University College, Gower-street, London, W.C. Annual Public Meeting. Address by Sir Dugald Clerk, D.Sc., F.R.S., on "Coal Conservation."

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Chain Helice Pumps," by Mr. F. A. Simpson.

SATURDAY, March 13th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, London, W. Lecture on "Positive Rays," by Prof. Sir J. J. Thomson, O.M., P.R.S. (Lecture IV.)

STOKE-ON-TRENT ASSOCIATION OF ENGINEERS.

7 p.m. At the Town Hall, Hanley, Stoke-on-Trent. Paper on "The Motor Car," by Mr. H. Swift.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Paper on "Advertising in the Engineering Industries," by Mr. W. E. Warrilow.

MONDAY, March 15th.

INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn Buildings, High Holborn, London, W.C. Paper on "Industrial Electric Heating," by Messrs. J. W. Beauchamp and S. M. Hills.

INSTITUTION OF ELECTRICAL ENGINEERS.
LIVERPOOL SUB-CENTRE OF THE NORTH-WESTERN CENTRE.

7 p.m. At the University, Brownlow-street, Liverpool. Paper on "The Application of the Electric Locomotive to Main Line Traction on Railways," by Lieut.-Col. H. E. O'Brien, D.S.O.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Aluminium and its Alloys," by Dr. W. Rosenhain, F.R.S. (Lecture I.)

TUESDAY, March 16th.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. At Great George-street, London, S.W. Lantern Exhibition of Views Taken Throughout the War Areas in France and Flanders, by Sir Alexander W. Kennedy, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH WESTERN STUDENTS' CENTRE.

7.30 p.m. At Houldsworth Hall, Deansgate, Manchester. Paper on "The Financial Organisation of a Manufacturing Concern," by Mr. H. J. Brocklehurst.

WEDNESDAY, March 17th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Street Passenger Transport of London," by Mr. W. B. Beaumont.

INSTITUTION OF ELECTRICAL ENGINEERS.—WIRELESS SECTIONAL MEETING.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Duplex Wireless Telephony: Some Experiments on its Application to Aircraft," by Capt. P. P. Eckersley.

INSTITUTION OF ELECTRICAL ENGINEERS.—SOUTH MIDLAND CENTRE.

7 p.m. At the University, Edmund-street, Birmingham. Paper on "The Protection of Alternating Current Distribution Systems without the use of Special Conductors," by Major K. Edgcumbe.

INDUSTRIAL LEAGUE AND COUNCIL.

7.30 p.m. At Central Hall, Westminster, London, S.W. Subject: "Our League: How can We Improve It?" by the Members.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Paper on "Bricks and Brick-making, from a Geological Standpoint," by Prof. P. G. H. Boswell.

THURSDAY, March 18th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Gt. George-street, London, S.W. Adjourned Discussion on "Notes on Operating a By-Product Producer Gas Plant for Power and Heating," by Mr. W. H. Patchell, and "Production of Power from Blast Furnace Gas," by Mr. S. H. Fowles.

FRIDAY, March 19th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "The Indian Currency System and its Developments," by Sir William S. Meyer.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "Exact Data on the Performance of Mechanical Stokers, as Applied to 'Lancashire' or other Narrow-Flued Boilers," by Mr. D. Brownlie.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN.

7.30 p.m. At the University, Sheffield. Lecture on "Some Steam Economies," by Mr. G. Rowe.

8 p.m. At the Y.M.C.A., Bothwell-street, Glasgow. Lecture on "Oil Tankers," by Mr. C. R. H. Bonn.

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

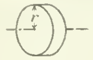
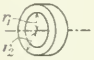
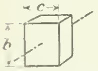
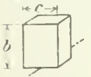
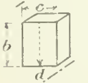
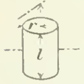
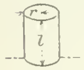
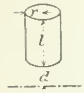
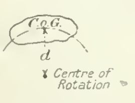
In the first section of this article, which was published in these columns about 18 months ago†, winders operating in vertical shafts were considered, and simple methods of drawing the torque diagrams for drums of various types were described. In the present series of articles it is proposed to deal with cylindrical-drum winders operating in inclined and compound shafts, and a knowledge of the elementary principles that were discussed in the first section of the article will be presupposed. The examples to be used for purposes of illustration are, without exception, taken from existing winders, and they include direct and geared three-phase, Ward Leonard and equalised Ward Leonard propositions. Before dealing with these, however, we desire to give a number of tables that will be required throughout the article, and to describe the method in general use for finding the rating of electrical machinery used for driving winding engines.

Methods of Estimating Moments of Inertia.

In connection with problems involving power required to accelerate, it is necessary to know the moment of inertia of the important moving parts. It will be remembered that the moment of inertia of a body is equal to $WR^2 \div g$, in which W is the actual weight of the body in lbs., R is the radius of gyration in ft., and g is the acceleration of gravity, namely, 32·2ft. per sec. per sec. The radius of gyration is of such a length that if the entire weight of the body is imagined to be concentrated at this radius from the centre of rotation, the stored energy will be equal, at the same speed in revolutions per minute, to the stored energy of the actual body.

Calculation of Moment of Inertia.—Although a rotating body will seldom correspond exactly to one of the forms shown in Table I., in most cases, however, the body may be resolved into parts which are approximately represented by one or other of the forms given in the table.

Table I.—*Radii of Gyration.*

(a)		Solid cylinder about its own axis $R^2 = \frac{r^2}{2}$.
(b)		Hollow cylinder about its own axis $R^2 = \frac{r_1^2 + r_2^2}{2}$.
(c)		Rectangular prism about axis through centre $R^2 = \frac{b^2+c^2}{12}$.
(d)		Rectangular prism about axis at one end $R^2 = \frac{4b^2+c^2}{12}$.
(e)		Rectangular prism about outside axis $R^2 = \frac{4b^2+c^2+12bd+12d^2}{12}$
(f)		Cylinder about axis through centre $R^2 = \frac{l^2+3r^2}{12}$.
(g)		Cylinder about axis at one end $R^2 = \frac{4l^2+3r^2}{12}$.
(h)		Cylinder about outside axis $R^2 = \frac{4l^2+3r^2+12dl+12d^2}{12}$.
(i)		Any body about axis outside its centre of gravity $R_1^2 = R_0^2 + d^2$ Where R_0 = radius of gyration about axis through centre of gravity. R_1 = radius of gyration about any parallel axis. d = distance between centre of gravity and axis of rotation.

For example, a large gear wheel can usually be separated into a rim, corresponding to (b) in Table I.; spokes corresponding to (e) or (h), and a hub corresponding to (b). The moment of inertia is found by multiplying the mass, namely, $W \div g$, by the square of the radius of gyration, and the total moment of inertia of the wheel will be equal to the direct sum of the moments of inertia of all the parts thus separately calculated.

In many cases the calculations can be simplified by determining the moment of inertia of the parts which are heavy and far from the axis of rotation, and adding a small percentage to cover the other parts. In the case of a spur or herringbone gear wheel of given dimensions the moment of inertia of the teeth may be figured as 40 per cent. of a hollow cylinder of the limiting dimensions, and the rim (exclusive of teeth) may be figured as a hollow cylinder. Adding 25 per cent. to the sum of these two moments of inertia will make proper allowance for the hub and spokes. If the weight and pitch diameter only are given, the moment of inertia may be considered to be the inertia due to 60 per cent. of the total weight concentrated at the pitch circle.

As regards the moments of inertia of drums, motor armatures and the like, the reader is advised to follow the advice of Mr. Hans C. Behr and keep a detailed record of the moments of inertia of the moving parts to serve as a guide in the designing of other plants. In the course of these articles we shall have occasion to deal with upwards of 100 winders and a considerable number of moments of inertia will be given for drums of various sizes and types.

Inertia of Motor Armatures.—For motor armatures the total weight and outside diameter constitute the only available data from which the moment of inertia can be estimated. This may be done by using the actual weight of the armature, or rotor, and a radius of gyration bearing a certain ratio to the outside radius, according to the type of motor. The ratio for slow and moderate speed motors is about 0·8.

As an example, take a winder motor of 550 H.P. running at about 70 revs. per min. The armature is 6·5ft. diameter and weighs 22,500lb. Using the ratio given above, the radius of gyration is equal to $\frac{1}{2} \times 0{\cdot}8 \times 6{\cdot}5 = 2{\cdot}6$ft., and the moment of inertia $= \frac{22{,}500}{32{\cdot}2} \times 2{\cdot}6^2 = 4{,}700$.

Unless the reader has in his possession a *useful list* of the properties of a range of machines he will have to guess the moment of inertia, and in guessing he may be wide of the mark. The preparation of what we call a useful list involves considerable labour and, as far as the author is aware, few firms disclose either in their catalogues or specifications technical information that it is vitally important the user should have, with the result that time is wasted in obtaining this information. A case in point is the inertia of the moving parts, armatures or rotors, of machines. In the case of an induction motor the air gap, rotor standstill volts and rotor full-load current as a rule cannot be obtained from makers' lists. But care is always taken in such lists to emphasise the fact that an extra will be charged for making some trifling alteration, such as lengthening the shaft by a couple of inches.

As a result of long experience makers of steam engines, without exception, give cylinder diameters and strokes of their engines as a matter of course, and the intelligent user can draw useful conclusions from the information. But in the electrical industry diameters and lengths of armatures are jealously guarded secrets, and as such serve to cloak waste of material. When manufacturers are alive to their own interests they will take pride in publishing information which shows at a glance whether they are using material as economically as their competitors.

In this article we are not concerned with the dimensions

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† The Electrician, July 5 to November 8, 1918.

of armatures. We shall, on many occasions, require moments of inertia of machines of large size, and in Table III will be found the moments of inertia of a considerable number of 50-cycle induction motors of outputs ranging from 100 H.P. to 2,500 H.P. and speeds varying from 94 revs. per min. to 375 revs. per min. Since these powers and speeds cover most of the cases occurring in practice the table is likely to be useful to those engaged in solving winder problems.

An example will serve to show how the table is used. A 16-pole 1,000 H.P. 50-cycle induction motor starting from rest is uniformly accelerated and attains full load running speed in 10 seconds. What torque must be exerted in order to overcome the inertia of the rotor?

A 16-pole, 50-cycle motor has a theoretical speed of $50 \times 60 \times 2 \div 16 = 375$ revs. per min. and the speed at full load will be 3 or 4 per cent. less than the theoretical speed or, say, 360 revs. per min. This corresponds to 6 revs. per sec., or $6 \times 2\pi = 36{\cdot}7$ radians per sec., and the angular acceleration is, therefore, $36{\cdot}7 \div 10 = 3{\cdot}67$ radians per sec. per sec. From the table it will be seen that the inertia of the rotor of a 1,000 H.P., 375 revs. per min. motor is 1.238. Hence, since the accelerating moment is equal to the product of inertia and angular acceleration, we have

$$\text{accelerating moment} = 1.238 \times 3{\cdot}67$$
$$= 4.550\text{lb. ft.}$$

Notwithstanding the fact that with the motor at rest the output is zero, the input in addition to balancing the iron and copper losses in the motor must nevertheless be sufficient to give rise to a torque of 4,550lb. ft. in order to start the motor. No matter at what speed this torque has to be exerted the input is the same and corresponds to the input when the motor

Table II.—*Inertia of Armatures of D.C. Winder Motors.*

Horse-power.	Speed, r.p.m.	H.P. ÷ r.p.m.	Armature weight, lb.	Inertia $WR^2 \div g$.
1,650	53·7	30·7	...	27,500
1,480	63·5	23·3	28,000	10·900
1,470	47·0	31·3	...	28,600
1,450	53·5	27·1	...	25,800
1,350	97·0	13·9	36,000	11,450
1,270	47·0	27·0	...	28,600
1,175	55·0	21·3	53,900	26,700
1,000	77·0	13·0	39,300	15,300
950	63·5	15·0	20,000	3,320
840	77·0	10·9	...	15,700
840	230·0	36·5	...	4,800
830	92·0	9·0	...	12,500
700	485·0	1·4	5,940	267
665	63·7	10·5	...	10,900
630	40·0	15·8	...	18,500
565	63·5	8·9	...	12,900
475	64·0	7·4	21·750	3,700
420	230·0	1·8	...	870
412	48·0	8·6	...	7,000
325	64·0	5·1	...	6,450
300	192·0	1·6	...	535
260	288·0	0·9	...	250
200	145·0	1·4	...	710

Table III.—*Inertia of Rotors of 50-cycle Induction Motors.*

Expressed as $I = WR^2/g$*, when W = weight in lb. ; R = radius of gyration in feet ; and $g = 32{\cdot}2$.

H.P.	Speed, revolutions per minute.									
	375	300	250	215	187	167	150	125	107	94
100	63	101	...	...	304	314	295	739	...	...
125	74	118	190	218	350	342	...	848	...	1,847
150	85	137	231	251	406	397	415	977	1,330	...
175	122	155	...	295	...	...	461	...	...	2,450
200	133	...	277	...	470	489	572	1,160	1,660	...
225	144	179	...	338	...	543	1,238	...	...	...
250	157	...	310	...	553	1,255	...	1,365	1,750	...
275	...	345	...	812	...	...	...	...	...	3,245
300	338	...	553	...	1,290	...	1,420	1,585	...	...
325	...	413	...	...	...	1,430	...	...	2,215	3,735
350	378	...	...	949	...	...	1,660	2,650	...	...
375	...	...	646	...	1,492	...	...	...	...	...
400	424	526	...	...	...	1,695	...	...	2,750	...
425	...	...	...	1,144	...	...	2,065	3,100	...	4,650
450	...	...	...	...	1,732	...	...	...	...	...
475	...	...	747	...	...	2,100	...	...	...	...
500	512	627	...	...	...	...	...	3,750	...	...
525	...	...	...	1,400	...	...	2,450	...	5,400	5,340
550	...	...	...	...	2,160	...	...	...	...	...
575	...	...	895	...	...	2,490	...	...	...	...
600	609	734	...	...	...	...	...	...	...	...
625	...	...	...	1,675	...	...	...	4,570	6,200	...
650	...	...	...	...	...	...	2,985	...	...	9,120
675	...	1,200	...	...	...	...	...	...	...	...
700	970	...	1,050	...	2,540	...	...	...	...	...
725	...	...	...	...	...	2,990	...	...	...	...
750	...	...	...	...	...	...	...	...	...	...
775	...	...	...	...	...	...	...	5,160	...	...
800	1,032	1,375	1,940	2,030	...	...	5,900	...	7,610	10,300
900	1,144	...	...	...	3,000	5,540	...	...	...	...
950	...	...	...	3,160	...	...	...	...	9,000	...
1,000	1,238	1,614	...	...	...	...	6,820	6,135	...	12,240
1,100	...	...	2,260	...	5,400	6,660	...	...	...	...
1,150	...	...	...	3,580	...	...	...	...	10,750	...
1,200	...	1,875	2,630	...	...	...	8,210	...	...	14,200
1,300	...	...	...	...	6,270	...	...	13,200	22,200	...
1,350	...	...	...	...	...	7,810	...	...	...	...
1,400	...	4,060	...	4,170	...	...	...	...	...	...
1,450	...	...	...	...	...	...	9,580	...	...	...
1,500	...	...	3,140	...	...	...	...	...	...	16,850
1,600	...	4,610	...	...	7,450	9,040	...	16,050	25,500	...
1,700	...	...	...	4,940	...	...	...	...	...	...
1,800	...	...	...	...	...	...	11,340	...	...	45,150
1,900	...	...	...	...	...	...	...	...	...	...
2,000	...	5,350	...	...	8,550	10,500	...	18,350	29,400	...
2,100	...	...	...	5,900	...	...	...	...	...	...
2,300	...	...	...	...	...	...	...	...	...	55,300
2,500	...	...	...	...	...	...	...	21,850	35,100	66,350

* The inertia is sometimes expressed as GD^2 in metric units, and GD^2 in $kg.m^2 = 5{\cdot}43 \times WR^2/g$.

is exerting a torque of 1,550lb. ft. at full speed. In other words the current input for accelerating the rotor alone is that corresponding to an output of $1{,}550 \times 2\pi \times 360 \div 33{,}000 = 303$ H.P. It is imperative that the reader should recognise this, and in the section on rating we shall show that the reduced speed heavy current parts of the winding cycle have a marked effect on the size of machine required.

For a given frequency the commercial speeds of a range of induction motors are limited to about 10 speeds as indicated in Table III. In the case of direct-current motors the speeds are much more elastic, and for this reason it is not possible to tabulate the inertia values of a range of low-speed direct-current motors of large output. Particulars are given in Table II. of a number of direct-current winder motors.

Table IV.—*Particulars of Armatures of Direct-current Machines of Large Output and Low Speeds.*

Ref.	Rating.		H.P. / R.P.M.	Armature.			D^2L / H.P. / R.P.M.	Weight. W lb.	Inertia. $WR^2 \div g$. lb. ft. units.	Rad. of gyration Rg. ft.	Ratio Rg. ÷ R
	H.P.	R.P.M.		Diam. D. in.	Length. L. in.	D^2L.					
1	8,000	60/120	133·1	108	90	1,050,000	7,870	154,000	60,800	3·565	0·801
2	3,500/13,700	50/100	70·0	108	70	815,400	11,650	130,000	52,200	3·6	0·808
3	4,600	45/90	102·1	126	45	715,000	7,000	84,500	43,800	4·09	0·779
4	4,000	60/120	66·7	108	45	525,000	7,870	77,000	30,400	3·565	0·801
5	2,500	40/75	62·5	126	45	715,000	11,420	84,500	43,800	4·09	0·779
6	1,500/3,250	28/36	53·5	144	28	581,000	10,860	69,000	39,750	4·31	0·718
7	2,800	60/120	46·7	108	35	407,700	8,725	65,000	26,100	3·6	0·808
8	2,600	75/150	34·7	80	45	288,000	8,300	52,000	9,930	2·48	0·745
9	900	28·5	31·55	126	25	397,000	12,590	47,000	22,400	3·92	0·747
10	2,300	85/170	27·05	80	35	224,000	8,275	44,000	8,230	2·46	0·739
11	1,420	53·5	26·55	126	25·25	401,000	15,700	48,000	22,960	3·92	0·747
12	750	33·4	22·45	126	18	285,800	12,720	42,000	20,000	3·92	0·747
13	500	32/37	15·62	108	20	233,600	14,930	34,330	14,590	3·7	0·832
14	1,450	96·0	15·1	108	20	233,600	15,450	36,000	15,300	3·7	0·832
15	1,500	120/240	12·5	80	25	160,000	12,800	38,750	7,860	2·56	0·769
16	650	60·0	10·82	90	20	162,000	14,960	29,300	7,670	2·9	0·774
17	650	80/125	8·125	72	20	103,760	12,760	20,060	3,370	2·33	0·776
18	1,000	130/300	7·69	72	20	103,700	13,490	20,200	3,430	2·33	0·776
19	550	80/135	6·875	72	18	93,300	13,570	17,950	3,020	2·33	0·776
20	400	60·0	6·67	72	21	108,960	16,320	20,560	3,450	2·33	0·776
21	750	125/200	6·0	72	20	103,760	17,280	20,000	3,370	2·33	0·776
22	540	130	4·15	60	16	57,600	13,880	12,100	1,213	1·8	0·72
23	350	100/220	3·5	60	14·5	52,200	14,910	10,600	1,038	1·8	0·721
24	500	150/250	3·33	60	13	46,800	14,050	9,630	970	1·8	0721

Weight W = weight of armature without shaft.

Table V.—*Inertia of Cylindrical Drums.*

Type.	Diameter, ft.	Width, ft.	Capacity per drum.	Total inertia* $WR^2 \div g$.	Remarks.
Single	17·0	8·0	......	105,500	Total weight, 69,000 lb.
,,	16·0	9·0	......	76,000	Total weight, 61,000 lb.
Double	14·0	7·0	......	64,000	......
,,	14·0	5·0	4,000 ft. of $1\frac{1}{2}$ in. rope	137,000	......
,,	14·0	5·0	4,200 ft. of $1\frac{1}{2}$ in. rope	138,000	......
,,	14·0	5·0	......	124,000	......
,,	14·0	5·0	4,000 ft. of $1\frac{1}{2}$ in. rope	145,500	......
,,	14·0	5·0	4,100 ft. of $1\frac{1}{4}$ in. rope	137,700	......
Single	12·0	8·0	......	35,600	Total weight, 43,300 lb.
Double	12·0	3·5	4,000 ft. of $1\frac{3}{8}$ in. rope	55,000	......
,,	11·5	5·5	5,350 ft. of $1\frac{1}{4}$ in. rope	55,000	......
Single	11·0	10·0	......	35,000	Total weight, 44,250 lb.
Double	11·0	8·0	......	75,900	......
,,	11·0	7·0	3,800 ft. of $1\frac{1}{2}$ in. rope	57,000	......
,,	11·0	5·0	......	54,500	......
,,	11·0	5·0	......	47,500	......
,,	10·5	...	4,500 ft. of $1\frac{1}{4}$ in. rope	22,100	......
,,	10·0	8·5	1,900 ft. of $1\frac{1}{2}$ in. rope per layer ...	111,800	12 ft. brake drums. Plate clutches.
,,	10·0	7·5	......	37,800	......
,,	10·0	6·0	4,290 ft. of $1\frac{1}{2}$ in. rope	45,000	......
Single	10·0	6·0	......	13,900	Total weight, 23,500 lb.
Double	10·0	6·0	5,100 ft. of $1\frac{1}{2}$ in. rope	46,250	......
,,	10·0	5·0	......	34,500	......
,,	10·0	5·0	5,100 ft. of $1\frac{1}{2}$ in. rope	49,000	......
,,	10·0	5·0	......	46,250	Flanges, 12 in. deep.
,,	10·0	4·7	1,000 ft. of $1\frac{3}{8}$ in. rope	40,000	......
,,	10·0	4·0	4,000 ft. of $1\frac{1}{4}$ in. rope	14,000	......
,,	10·0	4·0	3,000 ft. of $1\frac{1}{4}$ in. rope	16,000	......
,,	10·0	3·8	......	18,500	......
,,	10·0	3·8	3,000 ft. of $1\frac{1}{4}$ in. rope	15,000	......
,,	10·0	3·5	......	31,000	......
,,	10·0	3·5	4,135 ft. of $1\frac{3}{8}$ in. rope	32,000	......
Single	9·0	6·0	......	12,500	......
Double	9·0	5·6	4,900 ft. of $1\frac{1}{2}$ in. rope	18,500	......
,,	8·0	5·5	4,000 ft. of $1\frac{1}{4}$ in. rope	20,000	......
,,	8·0	5·0	4,000 ft. of $1\frac{1}{4}$ in. rope	18,000	......
,,	8·0	5·0	5,100 ft. of $1\frac{1}{2}$ in. rope	23,200	......
,,	8·0	...	4,000 ft. of $1\frac{1}{2}$ in. rope	21,800	......
,,	8.0	4·0	......	16,600	......
,,	8·0	3·0	2,200 ft. of $1\frac{1}{2}$ in. rope	15,000	......
,,	7·0	4·0	......	15,700	......
,,	7·0	4·0	4,000 ft. of $\frac{7}{8}$ in. rope ...	12,500	......

* By "total inertia" is here meant the *inertia of the whole of the rotating parts excepting the motor.*

Further particulars are given in Table IV. of the armatures of large direct-current machines of Metropolitan-Vickers manufacture

Inertia of Drums.—In the accompanying tables are given the inertia values of a number of drums of different sizes and types. From the figures given it is possible to strike average values sufficiently accurate for practical purposes.

The wide variations of the inertia values given in Table V. are due to a certain extent, to differences in the arrangement of the winders; but, to a very much greater extent they are due to bad design. In a later section of the article notes will be given on the design of drums, but we would here state that the high inertia values that are necessary in the case of a steam-driven winder should be avoided as much as possible in an electrically-driven machine. This point is, as yet, imperfectly understood by many of those whose experience has been gained from the steam engine. The author is of the opinion that, by applying scientific principles to the design of drums, it should be possible to reduce the inertia value by 25 per cent. in the case of small drums, and by an even higher percentage in the case of large drums.

Inertia of Koepe Pulleys. Although but little used in this country, Koepe-pulley winders are often met with on the Continent. An example of such a winder will be given towards the end of the article, and particulars of a number of pulleys are set out in Table VI.

Table VI.—*Properties of Koepe Pulleys.*

Diameter, ft.	Radius of gyration, ρ ft.	ρ : radius.	Weight, W lb.	Inertia, $W\rho^2 \div g$.
26·2	9·40	0·72	48,500	133,000
23·0	6·03	0·53	66,000	74,300
21·5	7·67	0·71	30,400	55,300
21·0	7·40	0·70	41.200	70,000
18·0	5·84	0·65	31,300	33,400
15·0	5·05	0·67	31,400	25,000
12·0	4·03	0·67	24,700	12,500

The view has been expressed that one of the advantages of the Koepe pulley winder is the low inertia value of the rotating masses. From an inspection of the table it will be seen that the inertia of the Koepe pulley is much higher than is generally supposed.

(*To be continued.*)

Electricity in Connection with X-Ray Work.

At a joint meeting of the Institution of Electrical Engineers, the Royal Society of Medicine (section of Electro-Therapeutics) and the Röntgen Society, held on February 26th, three Papers, of which we give abstracts below, were read dealing with electrical problems and apparatus met with in connection with X-ray work.

The Efficiency of High-Tension Transformers as Used for X-Ray Purposes.

By REGINALD MORTON, M.D., F.R.C.S.

For some time it has been evident that, in the absence of some fundamental change in our methods of generating X-rays, further development in the science of radiology would be limited to matters of detail. Improvements in apparatus and methods have been made, but, so far as the real essentials are concerned, we are no further on than we were a dozen or more years ago.

The chief object of this combined meeting is to explain our difficulties to the members of the Institution of Electrical Engineers and the Röntgen Society in the hope that they may be able to suggest a more efficient means of exciting our X-ray tubes. The curves obtainable respectively from a coil and a transformer (rectified) are illustrated in Figs. 1 and 2. Experience shows that the first is more efficient up to the limit of its capacity. We get more penetration and more actinism for a given current, greater steadiness, less heating and a longer useful life for the X-ray tube. The ideal current consists of extremely high-voltage impulses of very brief duration, yet sufficiently sustained to have an appreciable time factor—*i.e.*, to persist for a small fraction of a second. Such current as would pass through the tube by virtue of those lower voltages represented in the above curves should be suppressed or diverted, for experience suggests that it is through the influence of the higher voltages alone that we get useful X-rays from our tubes.

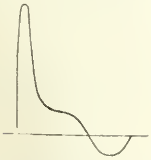

Fig. 1.

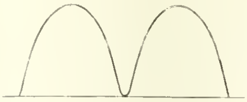

Fig. 2.

With a suitable coil, the initial rush of current has a very high magnitude, but its duration is extremely short. Notwithstanding its brief duration, it is this impulse that makes the coil current so efficient up to the limit of its capacity, and it is the absence of any such high-voltage impulse that keeps the efficiency of the transformer current so low. Of the total radiation from a tube energised by a coil, probably no more than 20 per cent. consists of useful rays; energised by a transformer, the proportion is probably less than 10 per cent. Improvement in efficiency is not only possible but easy. Instead of demanding more milliamperes, let us measure the efficiency of our apparatus by the radiological result obtained from a given number of milliampere-seconds on both plate and pastille. That is the only thing that matters to the practical radiologist, and to increase this efficiency the manufacturer will be obliged to cut out the lower half of the coil curve, and probably not less than 80 per cent. of the transformer curve. This radical departure from usual practice will be followed by a distinct gain in efficiency.

Problems of Interrupted and Fluctuating Currents.

By MAJOR C. E. S. PHILLIPS, O.B.E.

The velocity and quantity of the electrons in an X-ray bulb are the principal factors controlling the design of electrical apparatus required for radiography. Medical experience points to the need of an electron speed such that the resulting X-rays shall be as penetrating as the Gr. gamma X-rays from RaC. But even with 170,000 volts between the electrodes of the tube we can only get a ray about half as penetrating as this. Recent experiments show that at least 600,000 volts would be required to produce a similar ray from an X-ray bulb; possibly nearer 2,000,000 volts might be needed. There are other calls for highly penetrating rays; metallurgists are asking for a machine that will give 300,000 volts. For instantaneous radiography in medical institutes large currents are also needed at these high voltages. In some cases the power put into the tube itself has exceeded 14 kw.

This represents one end of the scale. On the other hand, there is the radiography of wood, and a wide range of other uses necessitating only moderate electrical plant. There are also the needs of the Army and Navy, as well as many special applications, and it becomes a question whether one type of apparatus can best fulfil all these requirements.

So far, electrical induction provides the most practical way of producing high-tension electricity for X-ray work. At present the tube is the most inefficient part of a modern high-power outfit. The induction coil has much to recommend it, but the interrupter constitutes the principal limitation; our troubles are divided between it and the condenser. The shape of the condenser is of importance. Of two condensers with the same capacity, one having long narrow leaves is not so effective as one in which the leaves are nearly square.

The weakest point of a coil outfit is undoubtedly the condenser, and an alternative path should always be provided to carry off any excessive surges of current into it, which may be short-circuited through a water resistance, with only a reduction of 20 per cent. of the coil output. Three 16 c.p. 250-volt carbon-filament lamps in series joined across the condenser terminals proved satisfactory, and there was no appreciable reduction of coil output.

The value of the interrupted current that may be safely used with a coil is limited owing to the flare when the primary current is broken. Interrupters are frequently imperfectly designed and constructed. Experiments with tantalum blades are required, as flare can by this means be reduced. Although tantalum is not "wetted" by mercury, it gives a perfect contact. The arc at break occurs in that case between the practically non-vaporisable tantalum and the mercury, and the speed of the motor assists in giving a sharper interruption of the circuit. In other cases the high surface tension of the mercury determines the suddenness of the rupture. Absence of flare is also necessary to ensure the efficient action of the mechanical rectifier. An attempt is being made to design an interrupter that will break 20 amperes quietly and continually without overheating.

The maximum P.D. obtained so far with any one small machine is 2,500 volts, and the usual practice consists in linking up three machines in series, each to give 1,800 volts. Thus a set for laboratory use gives about 5,000 volts, the P.D. being directly proportional to the speed. An output of 15 milliamperes can be obtained in this way, but insulation difficulties at higher potentials seem to exclude the possibility of developing this plan for X-ray work.

The design of transformers has reached a high degree of perfection. But where very high-tension work is concerned, and a rectifying disc is spun by a synchronous motor, the weak spot seems to be the insufficient guarding of the armature windings from induced surges of current. Earthing through a condenser, or other means of assisting the insulation of the armature to withstand the strain put upon it, is essential.

I venture to suggest a plan whereby the steeper P.D. wave required with transformers may be obtained. In 1895, and about six months before the discovery of X-rays, Messrs. Barr, Beeton and Taylor published a Paper in THE ELECTRICIAN* dealing with the question of changing the shape of alternator wave-forms by means of an "injector." It is therefore suggested that this wave be distorted synchronously by keying an "injector" to a small synchronous motor and connecting it in series with the main supply and the transformer. In this way a wave-form could be obtained which would render the rectifying disc unnecessary. The installation would not only be less costly, but weigh less, occupy less space, and be highly efficient for the requirements of X-ray technique.

High-Tension Transformers for X-Ray Work.

By RUSSELL S. WRIGHT.

Little systematic research work has been done on this subject. We have not yet even reached a satisfactory classification as regards output and efficiency. An advance upon the spark-gap method of measurement has been taken by stating how many milliamperes a certain coil will pass through an X-ray tube of a given alternative spark-gap; but this is still anything but satisfactory, as the reading of an ordinary moving coil milliammeter is of very doubtful significance. In this view, "efficiency," as understood by an electrical engineer, matters little. But as regards qualifications we know next to nothing. We do not yet know whether a succession of high-peaked waves are better or worse than a smaller number of oscillations longer maintained, nor yet whether the tops of the peaks only are of value, or whether outputs of lower potential play their parts as well, possibly in bringing out details of the softer tissues of the body.

In the case of an induction coil, it is doubtful if we have yet any means of ascertaining what the peak value of our discharge really is. The point of highest potential is only maintained for an exceedingly short interval, and it is doubtful whether any recording instrument at present available will really measure it. The time is now ripe for a definite move forward, and radiologists, electrical engineers and physicists should come into partnership in the attempt to solve a very baffling problem. I would further suggest that the British Scientific Instrument Research Association is the proper body to co-ordinate and direct the work of the three.

In the case of the high-tension transformer, the problem is simpler, as we are at all events dealing with a curve of sinusoidal character, somewhat modified and even distorted, it is true, but still essentially sinusoidal.

In the original interrupterless machine, as introduced by Snook, we had, in fact, a real sinusoidal curve with every alternate wave inverted. In the modern machine, the curve is neither sinusoidal nor symmetrical, but rises gradually and falls quickly. The direct measurement of such a current by means of an ordinary moving coil milliammeter is more correct and consistent than is the irregular discharge from an induction coil.

A closed circuit transformer also adapts itself far better to the indirect measurement of its output than does the induction coil, because its electrical efficiency is far higher and more easily computed. Efficiency is itself unimportant, but if it can be ascertained it assists enormously in calculating the secondary output.

I suggest, therefore, that an alternating-current high-tension transformer be taken as the basis on which to work, and that an attempt be made to classify induction coils according to their effective outputs for the purpose of the radiologists, and compared with a transformer of standard size and efficiency. An overload rating is justifiable. Our earlier machines were so rated by about 100 per cent., and an authoritative ruling is required. Equally important is a definite understanding as to the nature of the wave-form desired. But there are limits.

The "life" of coils and transformers is far less than it was 10 or even five years ago. The continual use of a coil for "deep therapy" is undoubtedly the most prolific cause of breakdown. An output of, say, 3 milliamperes at a 12 in. spark-gap from an instrument capable of giving, say, 100 milliamperes, means that it is kept at a high potential on practically open circuit for long periods at a time. The exposed end of a secondary winding is in a constant state of effluve, the discharge literally spitting away in all directions. Sooner or later the insulation is bound to go.

Various devices can be used to safeguard more or less the end windings, but the only real remedies are two: Either we must wind an instrument for deep therapy alone, or we must adopt oil insulation. The former course entails the radiologist installing two pieces of apparatus viz., one for therapy and one for radiography. The latter will do all the work with one, but will be heavier, larger, and more expensive. Similarly, should we concentrate on oil insulation, or would two separate instruments be practicable?

DISCUSSION.

Prof. A. SALOMONSON said in practical work one could not see any appreciable difference between the results obtained by using an induction coil and a high-tension transformer. For therapeutical work a coil was best, and was also cheaper. Tests of two dry transformers, rated at 4 kw. and using 3 kw., showed the efficiency of one was 0·90 and of the other 0·89. With regard to induction coils, the smallest coil tested gave the best result—about 0·80; but that was while it was moving up to its fullest capacity (about 1 kw.). But induction coils were seldom used in that way, but with interrupted currents, when the results were 0·68 and 0·75 for two different coils. Using the break current only, and testing with a mercury rectifier, the efficiency fell to about 0·60 or 0·65.

Prof. G. FORTESCUE said if a hot-filament rectifier and a condenser were used, he thought it possible for the whole discharge (with a Coolidge tube, at any rate) to be at a high voltage.

Major G. W. C. KAYE said for the last year or two radiology had been hampered by lack of units and standard methods of measurement. A handy way to measure volts was to use a sphere gap with spheres as big as the maximum capacity one had to employ. Efficiencies in X-ray work would appal the electrical engineer. A transformer was used with an efficiency of 90 per cent. and a coil with 50 per cent.; but the efficiency of the X-ray bulb was about one in a thousand.

Dr. A. E. BARCLAY was satisfied that, from a purely unscientific point of view, milliamperage was utterly useless. The first part of the impulse was what counted, and what went on after did not matter.

Mr. R. C. CLINKER said Dr. Morton showed a high peak for the induction coil in the positive direction, followed by a small peak in the negative direction. He did not think that was the voltage produced by the coil. What radiologists wanted was current passed through the tube at a continuous high voltage, which was best obtained from a high-frequency generator. In the comparison between induction coils and transformers that had been made, had the tests all been made at the same maximum voltage? If so, one might expect a transformer to give a larger quantity of X-rays than a coil. The wave shapes required could be obtained by working a transformer at a very high magnetic density at the core, and using a resistance in series.

Dr. D. OWEN said an effect could be produced on a plate in one of two ways with a soft ray and a very intense field, or with a harder ray and moderate intensity. He thought the latter was what was wanted. Prof. Taylor Jones had proved conclusively that the radiation was given out at the time of the high peak. Dr. Loewe stated that if the voltage were kept constant it was found, in the coil, that the milliampere-seconds gradually grew as the current was increased. With a transformer, the milliampere-seconds were constant with the current, and the milliamperes were inversely proportional to the time.

Dr. G. HARRISON ORTON said he did all his therapy with the coil and his radiography with the transformer, as that seemed to give the best results. For electrotherapy they required a machine that would give a current of very high potential, capable of operating a tube of 12 in. or 14 in. spark-gap, and stand such potential for long periods. For radiography they wanted a machine that would enable them to obtain photographs from the chest at a greater distance from the tube and in less time than it now took.

Mr. W. E. BURNAND said the output of useful rays varied as the cube of the applied voltage, and, if the curves of potential were plotted out on that cube basis, it would be seen that the upper parts of the voltage were the only part that mattered as regarded useful rays. The energy required in the tube was a comparatively small item.

Mr. F. J. HARLOW did not think the oscilloscope showed the voltage characteristic at all. He agreed with Dr. Morton that the effect of the spark-gap in the secondary was to cut out the low voltage current.

It was decided to hold a further meeting in the early autumn of this year, when the subject will be further discussed.

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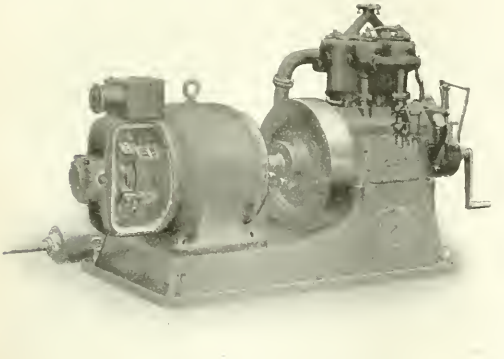
* *The Electrician*, June 21, 1895, p. 257.

British Industries Fair.

Birmingham Section.

Austin Motor Company, Birmingham. (Stand 69, Building A.)—Here were to be seen complete house lighting plants in working conditions. Three sizes were shown, the smallest being the Austin 0·75 kw. "Autoplant" complete with battery. This plant was used for lighting the company's stand. The next size is an Austin 3 kw. automatic plant with standard switchboard, and the next an Austin 5/7 kw. automatic electric lighting plant complete with battery. The two latter sets provided current for lighting several of the other exhibitors' stands.

The Austin 0·75 kw. "Autoplant" consists of a vertical four-stroke water-cooled engine, direct-coupled to a 15/11 ampere 50/70 volt 1,000 revs. per min. reverse compound-wound generator. Both engine and dynamo are designed as one unit, and are mounted on a combination bedplate together with the ignition coil and a pilot motor for operating the voltage-regulating brush and "start" and "stop" mechanism. The engine is cooled by means of a standard seven-column radiator, circulation being effected by the thermo-syphon system. A petrol tank is fixed to the radiator on brackets, and is so arranged that the level of petrol in the tank is always below that of the jet in the carburetter. This arrangement obviates the necessity for any taps in the petrol pipe and so avoids leakage. The petrol feed is by suction. A small switchboard on which is mounted a controlling instrument, ammeter and "start" and "stop" switch, is provided.



Typical Austin Lighting Set.

The operation of the plant is as follows: By pressing the switch to the position marked "start," the pilot motor is set working and travels the third brush on the dynamo towards its "starting" position. During this operation, the starting and ignition brushes are held clear of the commutator by a catch plate. As soon as the travelling brush reaches the starting position, the starting and ignition brushes are pulled on to the commutator by a spring, thus connecting the dynamo to the battery. This will cause the dynamo to run as a motor. Petrol is then sucked up from the tank through the carburretter, and the engine begins to fire. As soon as this occurs, the starting switch is released and returns to the automatic position. The dynamo now commences to charge the battery, causing its voltage to rise, and by means of the controlling instrument, the travelling brush operated by the pilot motor moves until the pressure on the lights attains the correct figure of 50 volts. As the battery charges, the travelling brush moves further away from its companion brush, maintaining a constant voltage on the lamps, until finally, when the battery is fully charged, the travelling brush has its further movement prevented by a "stop." The pilot motor continues to run until the starting and ignition brushes are forced into the "off" position, the battery then taking the load until it is discharged. When the voltage of the battery is down to the figure prescribed by the makers as being the minumum, the pilot motor comes into operation again, moving the travelling brush to the starting position, when the starting and ignition brushes are connected to the commutator, and the process described above is repeated. It will be seen from the above description that the plant is entirely automatic, starting when the battery is discharged, regulating the voltage on the lights during charge, and stopping when the battery is completely charged. The engine at present is designed to run on petrol, benzol or town gas.

The Austin 3 kw. automatic lighting plant consists of a four-cylinder 6 h.p. engine coupled to a 27½-22 ampere, 100-140 volt, 1,150 revs. per min. reverse compound-wound dynamo, both mounted on a cast-iron bedplate. The engine is cooled on the thermo-syphon system, using cooling tanks. In this case the engine starts up on petrol, and the change-over to paraffin is effected by hand, but equipments are built in which the change-over is automatic. In connection with this set is a cell-regulating switchboard which keeps the voltage on the lamps constant, both when charging and discharging, by automatically adjusting the number of cells in the discharge circuit. It also starts the set when the battery is discharged, stopping it when it has become fully charged. In other words, it is claimed, this plant does automatically what it is necessary to do by hand with the ordinary switchboard. It will be noted that, in the case of this equipment, the pressure is kept constant by cell-adjustment, and not by a third brush as in the Austin 0·75 kw. plant previously described. The automatic voltage regulation of the Austin sets is a most important feature, as it prevents the pressure on the lamps from rising above normal, thus considerably increasing their life. With both the equipments described above, arrangements are included which automatically disconnect the dynamo from the battery in the event of any failure in the supply of current to the battery during the charging operation, and also shut off the fuel supply when the plant stops.

The Austin 5/7 kw. automatic battery booster plant, which is also shown, consists of a twin-cylinder engine, 10-11 h.p. four-stroke, water-cooled, direct-coupled to a 5 kw. 46 ampere, 110 volt generator running at 860 revs. per min., which in its turn is coupled to a battery booster, separately excited for an output of 40/0/10 volts, 46-80 amperes, the three machines being mounted on one cast-iron bedplate. Together with this equipment is a three-panel switchboard. On the left is a starting panel for taking current from the battery and starting the set up by "motoring" the dynamo. The right-hand panel has mounted thereon a double pole, double-throw switch to enable current to be taken direct from the battery, or from the battery and booster, or from the battery and booster in parallel with the dynamo. The centre panel is equipped for automatically shunt-regulating the booster so as to maintain constant loading on the dynamo at 46 amperes. This current will charge the battery in the event of there being no load on the system, or will distribute its current between the battery and the load, or in the event of the load exceeding the output of the dynamo, then the dynamo current will assist the battery and provide current for the load up to a maximum of about 12 kw. at 110 volts. The plant has been designed with the object of using a small generating set to run at full load during the whole 24 hours, a large battery being installed to deal with the peak loads. By this system it is said the load factor can be maintained during the winter at approximately 100 per cent., thus keeping down the capital charges and also raising the overall efficiency to a very high figure. It was intended to run the engine by means of an automatic suction gas plant, but owing to the moulders' strike it was not possible to get the plant ready in time, and it consequently ran on town gas.

The Austin Motor Company are, we understand, prefecting a system for running an electric lighting set in conjunction with a gas-producer plant, suitable for hotels, villages or large country houses, utilising anthracite or peat as fuel. By this means it is hoped to be able to reduce the generating cost to less than 1d. per unit generated. At the same time, the capital outlay will be kept at a very low figure for the reasons outlined above. The whole plant will be entirely automatic, and will require attention for perhaps an hour a day. Our illustration shows a typical set.

Tok Mfg. Company, London (Stand 62, Building A) were exhibiting their British rotary snap switches, which have already been described in The Electrician.

Crabtree & Company, Walsall. (Stand 50a, on their own premises.)—This company showed their standard quick make-and-break tumbler switches, also ironclad conduit switches.

Premier Electric Heaters, Birmingham. (Stand 1, Building A.)—Here there were a comprehensive range of heating and cooking apparatus, articles commanding a special interest being a new type of electric iron fitted with patent cord grip connector, an electric kettle, and domestic cookers. The company are putting these three articles prominently forward because they are in a position to produce them on mass lines.

Sun Electrical Company, Ltd., London. (Stand 3, Building A.)—On this stand were to be found the well-known "Sunco" products including electric fires, switchgear, fuse boards, reflectors for industrial lighting, electric signs and flashers, Excel heating apparatus and specimens of Kalkos system of conduit wiring.

The Edison Swan Electric Company, Ltd., Ponder's End, Middlesex. (Stand 35, Building A.)—On this stand were exhibited a complete range of electric light fittings, glass ware, electric light accessories, switchgear, wires and cables, conduits, electric bells and bell accessories, electric indicating instruments, and primary and secondary cells.

Chloride Electric Storage Company, Manchester. (Stand 15 Building C.)—Chloride accumulators are well known to the trade, and do not need description. On this stand a complete Chloride storage battery was seen in use in connection with the country house electric lighting plants of the Austin Motor Company, described above.

Midland Electric Mfg. Company, Ltd., Birmingham. (Stand 56, Building A.)—On this attractive little stand there was a display of this company's ironclad switch and fuse gear. Their products are generally well known to the trade, and do not need a detailed description. They are none the less useful for that

F. & C. Osler, Ltd., Birmingham. (Stand 57, Building A.)—On this stand were a very comprehensive collection of electric light fittings in wrought and cast metals, and cut crystal glass. This firm specialise in the reproduction of historic models, and very beautiful examples were exhibited.

Industrial Appliances, Ltd., London, N. (Stand 503, Building C.) were exhibiting the Railodok Electric Truck for use at railway stations, docks and warehouses, where the swift handling of goods is a consideration. Three types of trucks were shown, the first having a capacity of 15/20 cwt., and two of 2 tons, one a box frame truck, the other a drop frame truck.

Western Electric Company, Ltd., Birmingham. (Stand 511, Building C.)—This company, representing British Electric Vehicles, Ltd., showed electric trucks and locomotives, and also inter-communication telephones, telephone switchboards, magneto and central battery telephone instruments.

Relay Automatic Telephone Company, Ltd., London. (Stand 383, Building B.)—Relay automatic telephone sets were to be seen on this stand. The chief claim for the system is that it employs relays only, complicated electro-mechanical switching devices being quite eliminated. The maximum movement in any part of the switchboard is 1/32 in. Throat transmitters are used, an invention by which it is claimed it is possible to speak in the noisiest workshops.

Benjamin Electric, Ltd., London. (Stand 42, Building A.)—Prominently displayed on this stand were found all types of industrial lighting fittings, strongly constructed of vitreous enamelled steel, and of direct, indirect and semi-indirect types, lanterns, street lighting, vapour proof and gas proof fittings, hand lamps, lamp holders, and a comprehensive range of lighting accessories.

Vickers, Ltd., London. (Stand 206/211, Building B.)—On this stand were shown "Cosmos" electric lamps and a case illustrative of the process of manufacture, as well as electric irons, kettles, glue pots and radiators.

Private Telephone (New System) Company, Ltd., Birmingham. (Stand 151, Building A.)—This firm had fixed on their stand a complete system of their automatic inter-communicating telephones.

Ward & Goldstone, Manchester. (Stand 43, Building A.)—The outstanding feature on this stand was the "Mercure" house lighting plant, a ¾ b.h.p. 25-volt belt-driven generating set, with battery charging switchboard; also a 3 b.h.p. of the same type.

The Jackson Electric Stove Company, Ltd., London. (Stand 63, Building A.)—Here were a complete range of electric heating and cooking apparatus. Apparatus for medical, dental, industrial and other uses were also shown.

Crystal Palace Section.

The main interest for the electrical industry at the British Industries Fair at the Crystal Palace was in the scientific instrument section, although even there there was not an abundance of things to look at.

Messrs. Newton & Wright, Ltd., showed a new X-ray dental unit, which is probably the most compact X-ray installation yet put on the market for serious work. It consists of an oil-immersed transformer working in conjunction with a self-rectifying Coolidge tube, the whole outfit, together with a protective tube stand mounted on an aluminium casting, forming the tank for the transformer, being arranged for easy manipulation on castors. As the outfit takes less than 5 amperes, it can be merely plugged into a lighting socket, and will work straight off the alternating-current mains.

Messrs. James Pitkin & Company, Ltd., had ready for patenting an interesting coil winding machine, which has been designed to wind automatically coils of one or more layers, the length of wire in the coil being measured correct to 1 mm. on a dial. In the operation of the machine the wire is traversed to and fro automatically, and a trip gear is arranged to register the number of layers and stop the machine when any desired number are completed. The standard size of the machines are for 8 in. maximum length of coil, and 3 in. maximum diameter; 14 in. length and 6 in. diameter, and 24 in. length and 12 in. diameter. No. 1 machine will wind the finest wire drawn—viz., 0·0012 in. to 0·0014 in. in diameter.

A number of more or less well known instruments were shown by Alexander Wright & Company, Ltd. There was the Simmance flicker photometer, CO_2 recorders, and a number of dead-beat recorders of various forms.

In the sections devoted to glassware a large number of firms were exhibiting electric bulbs and illuminating glassware. This section illustrated the enormous advances we have made as the result of the war.

In conclusion we were glad to note that some of the exhibitors had grasped the right idea of the fair, and have adopted closed-in stands. British manufacturers must get out of their minds the theatrical display sort of stands. Only trade buyers being admitted, they go straight to the exhibitors whose products interest them, do their business, and thus save valuable time which would otherwise be spent in travelling the country. In short, an annual British Industries Fair will fill the long-felt want of a centralised collection of representative products of British industry.

Failures of Turbo-Generators and Suggestions for Improvements.

We give below an account of the discussion on Mr. J. Shepherd's Paper on "Failures of Turbo-Generators and Suggestions for Improvements" which recently took place at a meeting of the Institution of Electrical Engineers in Birmingham and Manchester. An abstract of the Paper appeared in our issue of January 16 and 23.

DISCUSSION AT BIRMINGHAM.

Mr. W. Wilson said that anyone who had had marine experience must have realised that the introduction of electric drive would bring about a number of welcome improvements, while, at the same time the corrosive effects of the salt air were only too evident to those who had to maintain electrical apparatus exposed to its influences. Yet the difficulties of steam generation were not less serious than the author had stated, and the principal difficulty in the way was that of the cooling of the generators. The American Navy had recently been conducting experiments in marine propulsion. It would be interesting to know whether they had adopted liquid cooling in these cases.

Mr. W. N. Cranston said he understood that the author proposed to dispense entirely with the present system of air cooling and to substitute for it a system of water ducts. If we took 15°C. as the approximate difference in temperature required between the iron surface and the air in the duct and assumed the corresponding difference in the case of water cooling to be negligible, we could permit an internal temperature rise of 15°C. more. If we took 50°C. as the present temperature rise from all sources we could allow 40 per cent. greater loss provided all other things remained equal. Unfortunately this was not so since we relied on the cooling from the air gap surfaces of both stator and rotor as a valuable heat path. The efficiency of this path depended entirely upon a rapid change of the air in the gap taking place and in the author's ideal machine it would disappear. The importance of this would be evident when he said that in a machine having a stator loss of 200 kw. something like 60 kw. would be dissipated from the gap surface of the stator and a similar amount from the rotor. In the absence of air ventilation the whole of that heat would have to be conducted across the stampings, at the point of highest loss, and he was afraid this would practically absorb the whole of the 15°C. gained. Whatever might be the future of water cooling as an auxiliary he thought the main cooling medium would continue to be air. A gas had the great advantage over a liquid that the heat in it could be extracted mechanically even though it was at a lower temperature than its surroundings. This opened up great possibilities of using the turbo losses to some advantage.

Mr. R. G. Jakeman said that in common with several other speakers, he thought that the author has been rather unfair to the present designs of turbo-alternators. It would be very interesting and instructive if a second appendix could be added to the paper giving the number of breakdowns of this class of machinery for the past five or six years, together with the total number of machines in operation. In his calculations for liquid cooling the author appeared to have made the assumption that all the channels provided were completely filled with the liquid. Referring to the narrow slot shown in Fig. 8f. of the Paper it seemed quite likely, however, that the centrifugal force would cause the liquid to be flung outwards leaving a vacuum at the bottom of the slot. This would reduce the surface of the liquid available for cooling, and, although the velocity would be increased the advantage of this particular shape of duct would be considerably less than might be expected.

Mr. F. Forrest said the present method of cooling large turbo alternators by blowing through them large volumes of air could not be regarded as satisfactory, especially when one kept in mind that the cooling air might be saturated with moisture, and carried, as it usually did, a considerable amount of dirt. He believed future development would tend towards some system of liquid cooling which would be much more effective than the present crude method, and free from its obvious defects. There was grave risks in adopting water cooling for the stator of a high voltage alternator, and he did not believe that this would ever become standard practice. Forced oil cooling for both stator and rotor would be a satisfactory solution of the difficulty, although the volume of the cooling ducts for the oil as compared with those necessary for water cooling would be about two-and-a-quarter times as large. The specific heat of transformer oil was about 0·55, whilst its specific gravity was about 0·85. The oil could be circulated by a pump driven from the turbine shaft (in the same way as the lubricating oil was now delivered) and after passing through the machine could be cooled in a separate cooler. The cooling of the turbo generator would then be done in a similar manner to the latest method of cooling large transformers in which the oil was forced through the windings by means of a pump, and the hot oil cooled in an external cooler.

DISCUSSION AT MANCHESTER.

Mr. J. S. Peck said the author's reference to the weakness of open core construction was entirely a matter of the kind of supports which were put in to form the vent ducts and to secure the teeth at the end of the core. With very strong supports and suitable methods of putting up the laminations the core with radial vent ducts should be quite rigid. Contrary to the author's opinion, the speaker's experience showed that there were more troubles in the early days of turbo-alternators than there were to-day. Regarding joints, sweating was to be preferred to welding. The speaker's firm did not laminate stator bars so finely as some makers, but transposed the bars inside the slot, so that each bar occupied a symmetrical position in the slot. In this case the ends of the parallel conductors could be sweated together and a solid end connection used. Fire risks on machines were greatly reduced by using automatic devices which would disconnect the faulty machine from the 'bus bars and break the field. Whilst the author's proposed method of cooling looked simple, the insulation of the joints between coils was a very difficult matter. As stated by the author, water cooling had been used on rotors, but stators presented a very much more difficult problem. Welded or fused joints were very treacherous, and if this difficulty were overcome it would mark a new era in turbo-generator design.

Prof. Miles Walker advocated more Papers of this kind, in which a user would come forward and explain his objections. Water cooling had been successfully worked out in connection with rotors, and it remained now for the engineer to apply it to stators. The fundamental difficulty in the case of stators was that, in the case of a perfectly closed metal pipe, there was danger of currents being generated. If, on the other hand, the pipe was made in insulated sections, there was a danger of leakage. The suggestion of a high resistance metal for clamps was a good one, although the speaker was not aware of a very high resistance metal of sound mechanical properties. Could the author suggest some really good resistance metal, having, say, 50 times the resistance of copper, which would retain its mechanical qualities and not crystallise? Water or fluid cooling of stators would probably come in the future; the A.E.G. had successfully applied water cooling to the frame. The application of water cooling to the end connectors was a very difficult problem, and the speaker feared that the author's suggestions would not go far enough. Regarding the question of the amount of saving effected by using the heat from the cooling system, it was to be remembered that this energy was received in the form of heat, and not in the form of electrical energy. Had the author taken this into account? (Mr. Shepherd: "Certainly.") Prof. Miles Walker (continuing): It had to be taken in the form of heat at a low temperature, and in this form it was generally worth very little, and it would be surprising if the case quoted worked out at a capital value of £17,000.

Mr. Shepherd: "The exact figure was a 5 per cent. loss on a 10,000 kw. machine, representing 303 tons of coal per annum, worth at to-day's price £757. At 6 per cent. compound interest for 15 years this represented £17,500."

Prof. Miles Walker: In order to get the energy from the lukewarm water it had to pass through a heat engine. The value of this in money was something like 5 per cent. of the value of the electrical energy lost.

Mr. H. C. Lamb said the idea of collecting the heat from the generator by use of the condensate, and recovering it in the feed water, was at first sight very attractive; but in modern stations, equipped with the best methods of heating feed water, the saving on the coal consumption would amount to something less than half of 1 per cent. This matter would be decided by considerations altogether apart from efficiency. Fan draught and cloth filters were by no means ideal, but in stating the case for water cooling the author had unintentionally exaggerated the dangers of air cooling. The speaker's experience with a turbo-generator plant, which had grown from 20,000 kw. to 100,000 kw. during the past eight years, showed that only two cases of stator faults developed, and in no case could the trouble be attributed to the alternator itself. Prior to the period mentioned they had four cases of stator trouble, due chiefly to the use of cotton lapping on the end windings. The substitution of mica insulation cured the trouble. During annual overhauling it was simply found necessary to clean the windings thoroughly, blow out the ventilation slots and re-varnish the machines. The speaker's experience of a 17,000 kw. slow-speed plant over a period of 15 years showed 40 to 50 stator faults, due to the failure of cotton insulation in the slots. A comparison of maintenance costs showed that during eight years the turbo-alternator plant of 100,000 kw. to-day worked out at 0·3d. per 1,000 kw.-hours, whilst in the case of the slow-speed plant the figure was $1\frac{3}{4}$d. per 1,000 kw.-hours over a period of 15 years.

Mr. H. A. Ratcliff referred to the question of internal versus external reactance, and considered the better plan to be a moderate amount of reactance in the machine circuits—say 10 to 15 per cent. (preferably partly external) and in addition to divide the system suitably by means of reactance coils located either between the 'bus-bar sections or between the 'bus-bar sections and a common tie-bar, or some such equivalent arrangement. It would be a good scheme, if possible, to construct machines so that internal faults would necessarily develop as faults to earth, instead of between phases. The protection of the machines would thus be much simplified. Continuity of supply was of first importance, and it would be most unfortunate if, for the sake of a more or less illusionary 1 per cent. in efficiency, designers sacrificed anything likely to reduce the mechanical robustness of generators.

Mr. K. Baumann referred to the utilisation of heat losses in the alternator, and proceeded to prove that the saving was £1,700, and not £17,000, as stated in the Paper. There was a difficulty arising out of the use of condensate owing to the condensate temperature varying, due to variation of vacuum. Again, at high loads, when coldest water was desirable for cooling the alternator, the condensate temperature would be highest, resulting in a reduction of the overload capacity of the alternator. The speaker compared the trend of development of turbo-alternators with the development in cooling arrangements in turbo-compressors which had taken place during the past 10 years.

Mr. J. A. Kuyser said that to derive real benefit from water cooling the heat drop through the insulation should be reduced at the same time as the cooling of the iron was improved. Oil cooling in direct contact with the copper had been dropped owing to the tight joint difficulty. The author's recommendation of a continuous mechanical support to the stator winding was excellent if adequate insulation of the end connections could be obtained. A less drastic division of stator conductors was desirable. Eddy currents should be a maximum from the bottom of the slot to the top. The end connections should not be laminated if avoidable. The speaker had developed an improved form of winding consisting of laminated conductor twisted in the slots and connected to a solid end connector (Pat. 129788/1918).

Mr. G. A. Juhlin said it was now American practice to guarantee an ultimate temperature of 150° C. for mica insulation. He did not think full appreciation had been given to the fact that the greatest drop of temperature took place in the insulation and in the spaces, and owing to this fact the temperature of the end windings would be greater in the proposed machine than in the case of an oil-cooled machine. The same remarks applied to the stator where insulation difficulties aggravated the cooling troubles.

Mr. G. F. Sills thought that cases of trouble due to critical speed were rare. It was necessary to have the rotor coils accurately formed so that they occupied a radial position when running to avoid undue stresses and side slip. In the building up of the stator core it was necessary at various stages to oven heat the partly assembled core and pull it up tight. Regarding the stator conductor, where two bars per slot could be used and each slot made in three compartments a solid conductor could be fitted into the compartment farthest from the air gap, the middle compartment left free for ventilation and the outside compartment fitted with a laminated form of conductor drawn into a rectangular copper tube. This arrangement had given good service on machines up to 6,000 kw. Mr. Peck had referred to the employment of an automatic field switch. There was now an automatic field switch which, after opening the exciter field, closed it again in the reverse direction.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Mechanical World Year Book 1920." (London: Emmott & Company, Ltd.) Pp. 317. 2s. net.

"Baudot Printing Telegraph System." By H. W. Pendry. Second Edition. (London: Sir Isaac Pitman & Sons.) Pp. 184. 6s. net.

"General Conditions in Electrical and other Engineering Contracts." By W. S. Kennedy, LL.B. (London: Sweet & Maxwell.) Pp. x.+110. 12s. 6d. net.

"Intermediate Text-Book of Magnetism and Electricity." By R. W. Hutchinson, M.Sc. (London: University Tutorial Press.) Pp. viii.+620. 8s. 6d.

"Education and Training for the Electrical and Allied Engineering Industries." Report of the Education Committee of the British Electric and Allied Manufacturers' Association. (London: Edward Arnold). Pp. 64. 3s. 6d. net.

Heating and Cooking Notes.

Small Industrial Appliances.

Serviceable household appliances such as irons, soldering irons, glue pots, &c., have equally well justified their use in industrial work. For they are clean, efficient and economical, and the maintenance costs can be kept low. For example, a polishing iron for finishing sole edges (*see* Fig. 1) in bootmaking is required by every repairing bootmaker and every saddler who uses a polishing or glossing iron, usually a gas-heated one. Hat irons are another example of apparatus, and can be very generally used. Specially designed irons both for use on the crown and on the brims of hats have been made by the General Electric Company Ltd. Tailoring and laundry irons, are perhaps more generally used than many other pieces of small industrial apparatus.

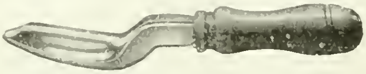


Fig. 1.—Bootmakers' Polishing Iron.

A rough type of labour is employed in laundries and it is therefore essential that the construction of the iron should be strong, particular attention being given to adequate housing of the connector to prevent mechanical damage. The flex must also be well protected and carried away from the connector in a fairly long spiral wire guard so that it does not get entangled with the iron when in use. The handle must not be too high, and should be shaped so that a good grip can be obtained and pressure exerted from the elbow when ironing. Economy can be assisted by the use of the iron stand in Fig. 2 which automatically cuts off the current when the iron is placed on it.

More attention has been given to the design of soldering irons owing to the increased demand caused by the war. A good example of this class of tool is the iron recently produced by the Quead Company, Ltd. It is well balanced, and the tendency for the tip end to face downwards when the iron is held in the hand has been overcome. The flex is so carried into the iron that there is no risk of a sudden pull occurring on the terminals if the iron is dropped. Close contact is made between the element and the copper bit, and the element is fixed in what is practically an air tight enclosure, thus reducing heat losses to a minimum. The loading is 100 watts.

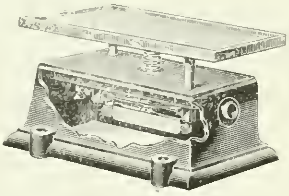


Fig. 2.—Magnet Automatic Iron Stand.

"Falco" Cooking Appliances.

The Falkirk Iron Company, Ltd., are numbered amongst the pioneers of electric cooking. The new "Falco" domestic cooker is designed for household use, and appears to be a serviceable piece of apparatus. The carcaso is of cast iron frame and sheet steel plate sides, particular care having been taken to ensure efficient lagging. The switches are mounted on the sides of the cooker. The hob is one piece of metal cast solid with the elements forming the hot plate sections, mounted underneath, as are the grill elements. The hob thus serves as both hot plate and simmering plate. A hinge enables the hobplate to be swung back, so that access to the elements can easily be obtained. The oven elements are at the side and the element guards carry the grooves in which the oven trays slide.

A serviceable trivet is fixed just beneath the oven door, and the complete cooker itself is mounted on four legs which raise the oven to such a height that the floor space beneath the oven can be conveniently kept clean. All the elements are of standard type, and are easily replaceable. Fig. 3 shews a general view of this cooker.

The "Falco" Compactum Cooker (Fig. 4) is another interesting example of development in cooker design. It consists essentially of a hobplate and grill. The grill can also be used as an oven by closing the door, which is hinged to the base of the compartment containing it. The outer portions of the hob can be used as a simmering plate, it is thus possible, it is claimed, to keep some three utensils boiling at the same time. The apparatus can be conveniently used on a kitchen table. Two sizes are made, one having a loading of 1,500 watts for the hob and 1,500 watts for the grill, and the other 2,000 watts for hob and grill respectively. The latter size has a slightly larger hob and grill compartment.

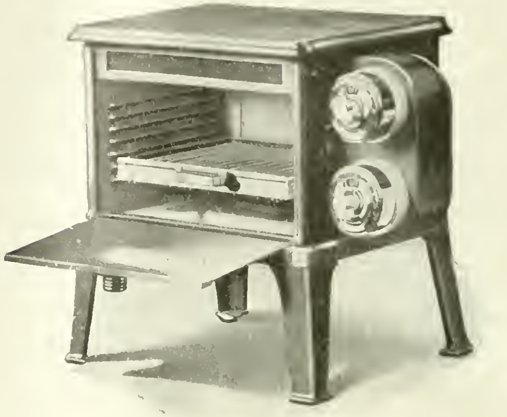


Fig. 3.—The "Falco" Domestic Cooker.

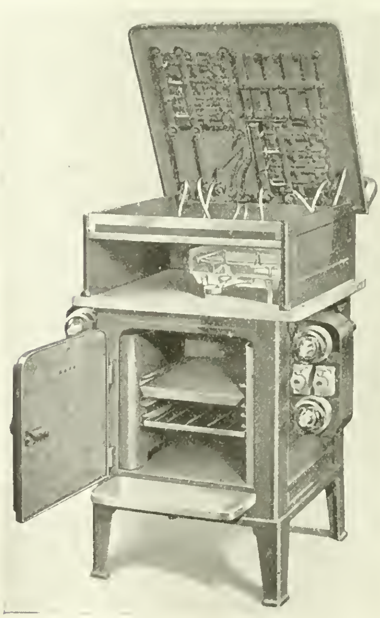


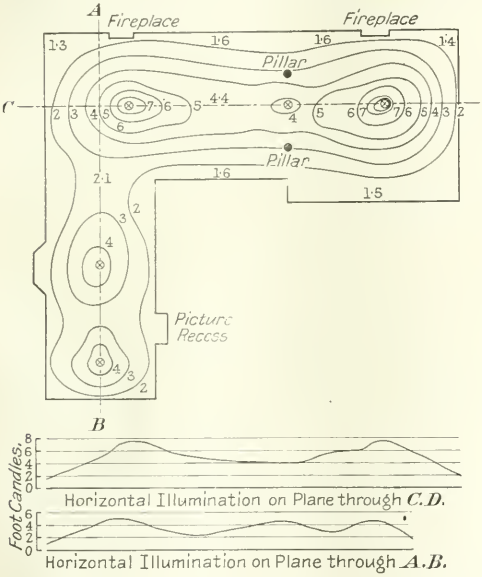
Fig. 4.—The "Falco" Compactum Cooker.

Three heat regulation is provided for both the hob and grill elements.

Electrical Equipment of the Naval and Military Club.

One of the features of the West-End of London are its clubs. These are of all sorts, from those where jazz music is a predominating feature to those where the most usual sight is an old gentleman asleep in an armchair. There is no doubt that a secret history of clubs in London should be written, but the columns of The Electrician are hardly the place to do it, and on this occasion we shall only refer to the electrical equipment of one of the better known of these institutions.

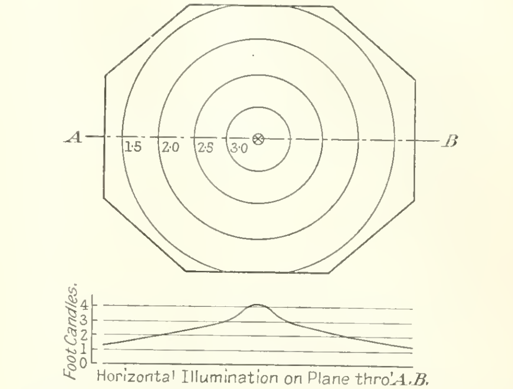
The Naval and Military Club was founded about 40 years ago with premises at the imposing house in Piccadilly which was occupied for some years by Lord Palmerston. In those days electricity was really in its infancy, but even then it was beginning to be recognised that there were certain conveniences obtainable by employing it. Shortly after the inauguration of the Club, therefore, it was decided to install the electric light and to put down private generating plant for the provision of the necessary current. The work of doing this was entrusted to Messrs. Crompton & Company, and two locomotive type boilers and two Bumsted-Chandler-Crompton generating sets were erected in a suitable building at the back of the Club. This plant, which was of the most modern kind at that time, was in operation until a few months ago. Great care was taken to prevent all vibration, and we understand there have never been any complaints on that score from the members, which is a tribute to the success of the work. Carbon filament lamps were, of course, employed, the wiring was on the tree system run in wood casing, and fittings of what may be called the chandelier type were used in all the principal rooms. The illumination thus provided was considered adequate at that time and, indeed, the installation generally seems to have proved quite satisfactory. As time went on the metal filament lamp was introduced instead of the carbon lamp, but the same fittings were employed for the purpose with rather more protection for eyesight while various modifications and modernisations to the generating plant were, of course, also made as occasion offered.



Single light bowl fittings equipped with "Wotan" half-watt type lamps. 1 near door, 150 watt; 1 in bay, 200 watt; 2 opposite fireplace, 500 watt; 1 between pillars, 200 watt.

Fig. 1.—Smoke Room. Walls and Ceiling Light.

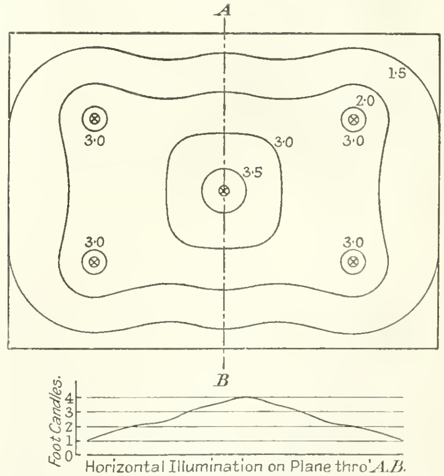
The tendency, however, to use larger and larger illumination units, a tendency which has been encouraged by the introduction of the gas-filled lamp, recently led the Club Committee to consider the question of installing half-watt lamps throughout the Club and generally modernising the installation. Messrs. Crompton & Company were called in in consultation and gave the very wise advice that the old capping and casing installation should be removed and a more modern type of equipment substituted, while it was also suggested that the generating plant should be pensioned off and the current required taken from the mains. This last advice was adopted not only for financial reasons but because the space occupied by the plant is badly needed by the Club authorities.



Single light bowl fitting in centre of room equipped with 300 watt "Wotan" half-watt type lamp.

Fig. 2.—Octagon Room, 21 ft. 6 in. × 18 ft. 6 in. to Opposite Faces. Walls and Ceiling Dark.

The rest of Messrs. Crompton's advice was taken in its entirety, and we recently had the opportunity of inspecting the new installation which is now in use on the Club premises. In dealing with this installation we need hardly do more than say that the most modern methods have been employed throughout. The wiring is all drawn into steel barrel, which is, of course, electrically continuous throughout and is earthed in the proper manner. A main switchboard is provided in a special room in the basement of the Club into which the supply mains of the Company are brought. On this board are the necessary meters for registering the energy consumed, and single-pole fuses and single-pole interlinked switches for each of the main distributing circuits. The supply is given by the Westminster Electric Supply Corporation on the continuous-current three-wire system at 440 volts across the outers and 220 volts



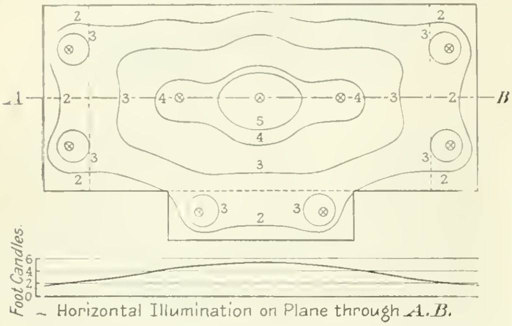
Single light bowl fittings equipped with "Wotan" half-watt type lamps. Centre fitting, 300 watt; side fitting, 100 watt (each).

Fig. 3. Library. Walls Dark. Ceiling Medium.

between each outer and the neutral, this latter, of course, being the voltage at which the lamps are supplied.

The arrangement of the lighting units throughout the Club has been thoroughly modernised. In practically every case half-watt lamps are used, the only exceptions being in certain of the passages in the basement and in such places as the linen closet and other similar stores where the lights are not in use for long periods at a time. In conjunction with the half-watt lamp bowl fittings have been installed and those in the main rooms of the Club are of an exceedingly artistic character, upon whose choice the Committee may be commended.

The result of this arrangement has not only a reduction of the energy consumption owing to the higher efficiency of the half watt lamp but a reduction in the number of points necessary for lighting the larger rooms. The large smoking room may be taken as a typical instance. This was originally lighted by 4 pendants, each pendant carrying 8 one-watt lamps. Instead of these 4 half-watt light fittings have been installed, each containing 1 watt half-watt lamps. The result of this change over is not only an increase in the illumination but a better distribution of light and a reduction in the energy consumed. The only possible criticism that can be made about the use of this modern system is that in some of the smaller rooms it has been found that a one-light fitting gives sufficient illumination. At the same time, of course, it provides no stand-by, and there might be occasions, say, in the middle of an important dinner, when the failure of a lamp will lead to a certain amount of trouble. That, however, is being captious, a state of mind that we do not like. We cannot do better, therefore, than congratulate the Naval and Military Club on having one of the most up-to-date lighting installations in London.



Single light bowl fittings equipped with "Wotan" half-watt type lamps. 1 centre fitting, 500 watt; 2 side fittings, each 300 watt; 6 in alcoves, each 100 watt.

FIG. 4.—COFFEE ROOM. WALLS AND CEILING LIGHT.

Institution of Electrical Engineers' Annual Dinner.

For the first time since 1914 the annual dinner of the Institution of Electrical Engineers was held at its normal season at the Connaught Rooms, London, on Thursday, March 4. During the war the dinner was not held, and in 1919 it was held in the summer, which is not a very suitable time for functions of this kind. Mr. **ROGER T. SMITH** presided over a company of about 450 members and guests, including, Mr. S. C. Aldington, C.B.E. (Gen. Man., Great Western Railway), Mr. W. H. Booth, O.B.E. (Electricity Commissioner), Sir Sydney Chapman, C.B., C.B.E. (Permanent Secretary, Board of Trade), Mr. A. R. Duncan (Controller of Coal Mines, Board of Trade), Sir Frank Heath, K.C.B. (Secretary, Dept. of Scientific and Industrial Research), Maj.-Gen. G. D. Jeffreys, C.B., C.M.G. (G.O.C. London District), Mr. W. W. Lackie, C.B.E. (Electricity Commissioner), Sir G. E. P. Murray, K.C.B. (Secretary, Post Office), Rear-Admiral Sir W. C. M. Nicholson, K.C.B. (Third Sea Lord and Controller, Royal Navy), Mr. W. Noble (Engineer-in-Chief, G.P.O.), Mr. A. Page (Electricity Commissioner), The Hon. Sir Charles Parsons, K.C.B., Mr. H. A. Payne, C.B. (Permanent Secretary, Board of Trade), Sir H. D. Rolleston, K.C.B., M.A., M.D. (President, Royal Society of Medicine), The Rt. Rev. Bishop E. E. Ryle, C.V.O., D.D. (Dean of Westminster), Capt. H. Riall Sankey, C.B., R.E. (President, Institution of Mechanical Engineers), and Mr. P. F. Rowell (Secretary).

In proposing the toast of the "Institution of Electrical Engineers," Sir **GREGORY FOSTER** said that schools of engineering had grown up amid the greatest difficulties. He was glad that the Department of Scientific and Industrial Research had been instituted and hoped that better organisation would be followed by greater progress.

Mr. **ROGER T. SMITH**, in replying, said that the membership of the Institution was now greater than that of any other engineering institution, numbering as it did about 8,800 members of all classes. Next year the Institution would celebrate its fiftieth birthday, and this ought to stimulate them to push forward the education of engineers and research workers to the utmost. He referred to the passing of the Electricity Supply Act as the most important event of the past year. He hoped that the Institution would render services to the State and to the electrical engineering industry in carrying out the provisions of this Act, unwelcome as these provisions must be to some. The Institution, however, represented all sections and it might fulfil, therefore, a useful function in becoming a clearing house for misunderstandings. The steady decentralisation of some of the efforts of the Institution was shown in the formation of 12 territorial centres in the United Kingdom and two abroad. It had been suggested that London itself should become a sub-centre of, say, Manchester, but he wished to impress upon members that all sub-centres cost money, and the finance question was one which was giving them greatest anxiety. In conclusion, he said that they all wanted peace. During the war they had many of them obtained spiritual peace, because they had been gladly giving service. Now there was unrest because that idea of service had disappeared. He felt sure that the secret of peace was service, and until service replaced class war peace would never be achieved. He commended to them the idea of service to the Institution and its interests.

Mr. **LLEWELLYN ATKINSON**, in proposing the toast of "Our Guests," referred to the establishment of an Overseas Trade Department of the Board of Trade. Government Departments did not always realise that what we were interested in was British trade and not simply trade.

General Sir C. F. N. **MACREADY**, in replying to the toast, appealed to all civilians who desired that the work of this country should be carried on without interference by a small minority to come forward in time of trouble and do their bit.

Lieut.-Col. Sir F. **YOUNGHUSBAND** also replied.

A reception was subsequently held.

The Imperial Wireless Controversy.

Correspondence between Mr. Godfrey C. Isaacs, managing director of Marconi's Wireless Telegraph Company, and the Prime Minister, and between Mr. Isaacs and the Secretary of the Imperial Communications Committee, has been published. In the letter to Mr. Lloyd George the fitness of Sir Henry Norman to act as chairman of the Sub-Committee on Imperial Wireless Communications is challenged, while in the second communication Mr. Isaacs declined to allow a representative to give evidence before the Imperial Communications Committee on long-distance wireless telegraphy. In his reply, Mr. Lloyd George intimates that Sir Henry Norman will not resign the chairmanship of the Committee.

Correspondence between Sir Henry Norman and the Prime Minister on the same subject appeared in "The Times" of the 5th inst. In his communication, which is a reply to Mr. Godfrey Isaacs' recent letter to the Marconi shareholders, Sir Henry explains his position, and maintains that he is without interest in any system of wireless telegraphy.

At the meeting of the Imperial Wireless Telegraphy Committee on Friday the following resolution was passed: "Having regard to the letter of the Marconi Company dated March 3, 1920, the Committee, in the absence of Sir Henry Norman, desire to put on record their unanimous opinion that his conduct of the business has given ample evidence of his complete impartiality. They feel confident that under his chairmanship an unbiassed consideration of the best interests of the country is ensured."

Profiteering in Conduit Elbows.

The Complaints Sub-Committee of the Central Profiteering Committee, under the Chairmanship of Mr. Marshall Freeman, heard a complaint last week by Mr. H. Underwood, electrical contractor, of Southend, against J. Sellar & Company, builders and wholesale electrical accessories dealers, also of Southend.

The complaint was to the effect that on Dec. 20, 1919, the respondent firm sold Mr. Underwood three ⅝ in. stamped metal elbows for electric wire conduit at 6s. per dozen; it was alleged that the same article could be bought locally at 3s. 6d. per dozen, and that a better elbow of solid metal was bought from the Edison & Swan Company at 2s. 4d. a dozen

Mr. **WALTER CUFF** (assistant manager of the Conduit Department of the General Electric Company) said his company now supplied to the trade in small quantities ⅝ in. stamped elbows at 1s. 3d. a dozen plus 50 per cent. 1s. 10½d. a dozen, and solid elbows were 2s. 9d. a dozen plus 75 per cent. 4s. 8d. a dozen. In November last stamped and unstamped elbows ⅝ in. were both quoted at 2s. 9d., plus 33⅓ per cent. 3s. 8d. a dozen.

Mr. J. Sellar admitted that he charged complainant 1d. extra for each elbow, as he did not consider he was really in the trade. The respondents were ordered to refund one-third of the charge.

Correspondence.

WIRELESS TELEGRAPHY AND TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : In reply to the query made by your correspondent in your issue of February 27 the transmission formula on p. 150 of my "Handbook" does indeed imply that under certain circumstances the power necessary for transmission varies as the sixth power of the distance for ranges exceeding, say, 1,000 miles : but I prefer to state the formula in another way, given below.

As regards proof I regret that I cannot offer a full discussion at present. The formula arose empirically many years ago out of a tabulation of the results published from time to time by the various authorities erecting and using wireless stations, and was without satisfactory basis till Austin and Cohen published their formula. At the present date we may arrange the reasoning as follows :—

The expression for the field produced by electric waves at a distance x from an oscillator and in its equatorial plane was given by Hertz, and may be written as proportional to $Ih \; \lambda x$ where I is the current and h the height of the sending antenna, λ is the wave-length and x the range. It was extended to the case of great distances over the earth's curved surface by Poincaré, who wrote it

$$\frac{Ih}{\lambda x}\varepsilon^{-ax},$$

where a is a term independent of the distance but dependent upon the wave-length. This formula was checked by the experiments of L. W. Austin, and may be taken as a fairly trustworthy guide for the transmission of signals in the day-time when strays are not bad, and it may be regarded as taking account of the curvature of the globe and of the absorption in the illuminated atmosphere and in the surface of the earth. Austin and Cohen showed that the experimental results indicated that the term a in the above expression is inversely proportional to the square root of the wave-length employed in the transmission. This has recently been confirmed by the diffraction theory of G. N. Watson.

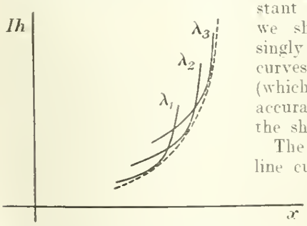
Watson's modification of the Poincaré formula has thus given a theoretical basis to the Austin-Cohen empirical formula. It expresses the field at a receiving station as proportional to

$$\frac{Ih}{\lambda x}\varepsilon^{-ax/\sqrt{\lambda}}$$

when a is constant. In order to produce a field of given magnitude at all distances and with any wave-length we must have

$$Ih \propto \lambda x \varepsilon^{ax/\sqrt{\lambda}}.$$

Suppose that curves be plotted with x as abscissæ and values of the product Ih as ordinates, λ being given a different constant value for each curve, we shall then obtain the singly infinite family of curves indicated herewith (which does not attempt accurate representation of the shapes).



The envelope of the full line curves is shown by the broken line. Its equation is obtained by differentiating the above expression partially with respect to λ and eliminating λ. On differentiating we obtain

$$x-\tfrac{1}{2}ax^2\lambda^{\frac{1}{2}}=0,$$

and on substituting in the original expression we find

$$Ih = cx^3,$$

where c is a constant, as the equation of the envelope. Stated verbally the last equation shows that if as distance increases the wave-length be varied so as always to produce the required signal intensity with the least possible value of Ih, then Ih must be proportional to the cube of the distance. Here in speaking of signal intensity it is tacitly assumed that the same receiving antenna and receiving apparatus is in use throughout the motion of the receiving station, that is as x varies. Whether the receiving apparatus is highly sensitive or very insensitive does not affect the form of the above formula ; it affects only the proportional factor.

If the transmitting station remains the same throughout the experiments the power required for signalling varies approximately as the sixth power of the range. But in practice higher antennæ are erected for long ranges than for short ranges, and this with other structural changes greatly alters the statement about the power necessary. It is for this reason preferable to think always in terms of the product Ih of the sending antenna and to use the formula last written.

In reply to the other question raised by your correspondent the proof of the formula for antenna resistance which I give on p. 129 of my second edition has never been published, though I have described it to two or three friends. I shall endeavour to communicate at an early date a short derivation of the formula.—I am, &c.,

London, March 6. W. Eccles.

THE TREND OF ELECTRICAL EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : I should like to make one or two comments on the article you published on February 27.

I did not wish to put forward any plea in favour of engineers learning shorthand, book-keeping or even company law. What seems to me most necessary is that the financial side of an undertaking, such as an electric power supply system, should be considered at College as well as its technical side, so that the students shall not look at engineering problems solely from the point of view of scientific efficiency. The factor of cost is a predominant one in practice ; it is fundamental, and as such it should be discussed.

At this University the matter has received careful consideration, and, although the new regulations have not yet been formulated, it is proposed to hold during the fourth year of instruction optional courses in subjects dealing with the commercial side of engineering, including scientific management, contracts and specifications, and the "human element" in factories, but these would not, of course, form subjects of University examination.

It is I think a matter for congratulation that a large number of important positions in industry, such as managers of railways and general managers of other large engineering works, are now being filled by men who have had an engineering education. May I again express my concurrence in the view that Mr. Peck has put forward, and which you support, that the soundest tendency in educational institutions is to specialise in fundamental principles.—I am, &c.,

Liverpool, March 2. E. W. Marchant.

LOSSES IN TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : While Mr. R. O. Kapp's article on this subject in your issue of February 13th is interesting, it deals with the subject from rather a narrow point of view, and, unless some of the other aspects are pointed out, it may be liable to encourage specifications which do not lead to the best all round results.

The manufacturers' objections to designing transformers in accordance with Mr. Kapp's article have already been pointed out by Mr. Kennett in your issue of February 20th. Mr. Kapp is, however, primarily concerned, quite rightly, with the user, who, after all, both pays the money and operates the apparatus.

What I wish to point out is that, even from the user's point of view, there are two serious objections to Mr. Kapp's proposals. First, specifying a high copper loss means a reduction in both permanent and short-period overload capacity, and to the user overload capacity is a very important matter. Secondly, I do not think it is at all certain that the high copper loss design actually results in cheaper running costs. Mr. Kapp falls into a very common error when he assumes a fixed price per unit for the losses quite independently of their nature. No engineer would think of supplying to an outside consumer a constant 24 hour load (such as the iron losses of the transformer) at the same price per unit as a load having a load factor of 27 per cent. (the figure Mr. Kapp gives for his copper losses).

In pre-war times a very common tariff was £1 per kilowatt maximum demand plus a farthing per unit. It would not be fair to take the selling price, as this would give too high a value to the losses; but the proportion between capital charges and running costs will be about the same. Taking as a suitable present-day figure for the value of losses on a medium size system £3 per kilowatt plus 0·2d. per unit, the value of the losses in the two cases Mr. Kapp considers work out at 23·8d and 22·9d. per annum per kilovolt-ampere installed, as against Mr. Kapp's figures of 3s. and 2s. 6d. Hence, it will be seen that if proper values are given to the losses the variation in the proportion between iron and copper loss of a transformer does not influence the actual costs appreciably. It is, therefore, much better to leave this ratio to be settled to suit the many other considerations which have to be taken into account in designing a transformer. I am &c.,

Newcastle-upon-Tyne, Feb. 21. J. R. Beard.

FOWLER'S BATTERY RULES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Two readers have something to say on my letter that appeared in your issue dated February 13. I will first reply to Mr. Mercer, because there appears to be only one point that he does not thoroughly understand—namely, the ease and quickness with which my rule will settle any case no matter how complicated. I did not try to make this clear in my first letter, being anxious to focus attention on the main point, which is this: my rule, rejected by Fowler's Electrical Engineer's Pocket Book, is demonstrably right; but each of the two rules given in that book is seriously wrong.

If we now suppose a case in which $N = 240$ and $k = 0{\cdot}75$, we may first notice that $sk = 180$ when $p = 1$. Then, knowing that sk varies inversely as p, we see that we want some value of p that is not very far from the square root of 180. Trying 12 as the most convenient approximation we get $p = 12$ with $sk = 15$. This tells us that no value of p can give a greater current than 12 does unless it is 13 or 14, which are the only integers between the above 12 and 15. But 13 and 14 are impossible, and our answer is therefore $p = 12$ or $p = 15$; each of these arrangements gives the same current, since $sk = 12$ when $p = 15$, so that p and sk are just as nearly equal in the one case as in the other. Your readers will have seen that Mr. Lisle's method takes much longer than this when applied to a much simpler case; and, as I will presently show, his method is not reliable.

Mr. Mercer thinks, however, that I should try to put my rule into such a shape that we have to make some single variable as near as possible to some constant. I can do this, as follows: Make $\log p$ as near as possible to $\log \sqrt{Nr/R}$. He will at once see that this is correct, since he has already noticed how we have hitherto been in search of a *geometrical* mean. But I much prefer the form given in my previous letter.

I was very glad to read the argument put forward by Mr. Lisle; for he makes the same mistake as Professor Miles Walker (of the Manchester University and College of Technology), and the correction of this in your journal may prevent any further misleading of Manchester's young electricians. I do not mean to suggest that the Manchester professors are too stupid to see their fallacy after I have pointed it out; my belief is that they dare not teach what they now know to be correct, for fear of offending the Board of Education examiners on whose authority the usual rule has been adopted.

Mr. Lisle points out that the statement $R = sr/p$ is only another way of saying $p = sr/R$; and this certainly shows that the usual rule is equivalent to mine *in the special case where the battery resistance can be made actually equal to the resistance of the external circuit.* But he (erring in the good company of Professor Miles Walker and others) has jumped to the conclusion that these rules will also be equivalent in every other case. If he had properly applied them to the simple test case that I mentioned he would have found that this is a great mistake. But when he attempted this application he forgot the conditions of the problem. He thought it was allowable to vary the number of cells in order to suit his calculated values of s and p.

Undoubtedly we get a problem of greater practical importance when we allow some of the available cells to be dispensed with, and for this I gave a "supplementary rule" in the last paragraph of my previous letter, which Mr. Lisle has evidently not read with due care. His method of dealing with this problem is always much more troublesome than mine, and is sometimes actually misleading, which mine never is. Take, for example, the case of $N = 26$, $r = 1$ and $R = 2{\cdot}05$. Here he would say $s = \sqrt{26 \times 2{\cdot}05} = 7{\cdot}3$, therefore $p = 26/7{\cdot}3 = 3{\cdot}56$; and he would then calculate the currents given by $p = 3$ with $s = 7$ and by $p = 4$ with $s = 6$, from which he would conclude that the latter is the best possible arrangement. But the best arrangement is really $p = 3$ with $s = 8$, as your readers can easily verify. Some of them may doubt my statement that Mr. Lisle's method would cause him to waste his time in calculating the current given by $p = 3$ with $s = 7$; for a greater current will obviously be given by $p = 3$ with $s = 8$. But a reference to his letter will show that I am not in any way misrepresenting him.—I am, &c.,

Newcastle-on-Tyne, W. F. Dunton.
March 1.

SCIENTIFIC AND TECHNICAL BOOKS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: One part of the descriptive catalogue of the British Scientific Products Exhibition, organised by the British Science Guild last year, was devoted to selected lists of books on science and technology.

The Guild has been asked to extend these lists so as to include not only all branches of science—both biological and physical—but also the chief technical subjects. It has undertaken to do this, and a committee, of which I am chairman, has been appointed to prepare such a catalogue.

The lists will be limited to books of British origin actually in current catalogues of the publishers, so that they can be obtained in the usual way through booksellers. School books and elementary manuals will not be included, and the general standard will be that of college courses in scientific and technical subjects, or of works' libraries. Each list will be submitted to authorities upon the subject with which it deals; but in order to secure that no important work is omitted, the committee invites the assistance of everyone interested in its task. Such aid may be afforded by sending (to the British Science Guild, 6, John-street, Adelphi, London, W.C.2) lists or single titles of British books of standard value or proved worth in any branch of science or industry. I shall much appreciate help of this kind which any of your readers may be able to give.—I am, &c.,

London, March 3. R. A. Gregory.

HARDENING AND TEMPERING—A CONFUSION OF TERMS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We receive a number of enquiries from electrical firms for furnaces for "tempering" steel. In the majority of cases what is really required is a furnace for "hardening" steel. In view of the activities of our gas friends we think that it would be well for electrical engineers to acquaint themselves more fully with the correct technical terms.

Hardening and tempering are distinct heat treatment processes. Hardening involves heating up to a high temperature, say, anything over 750° C., according to the nature of the steel. Tempering involves reheating after hardening to a comparatively low temperature, generally between 200 and 300° C., according to the nature of the work that the steel has subsequently to perform.

If electrical heating service is to progress it is in our opinion most important that there should be no uncertainties introduced into our speech or writings by the use of careless terminology.—We are, &c.,

Automatic and Electric Furnaces, Ltd.
London, Feb. 26. E. P. Barfield.

The Electrician.

FRIDAY, MARCH 12th, 1920.

Price ONE SHILLING. By Post 1s. 1d. Ann. Sub.: U.K. 52s., Abroad 54s.

Editorial and Publishing Offices:

8, BOUVERIE STREET, LONDON, E.C.4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

Power Supply in the Rhine Valley.

There was a time when with our national habit of self-depreciation we were accustomed to look to Germany as a mentor in everything electrical. A design, a policy, a system were good because they were German, and they were worthy of adoption in this country for the same reason. That stage has been passed. We are once again beginning to be interested in German electrical work, it is true, but we are interested in a spirit of criticism, certain that though we may learn from our erstwhile enemy we shall no longer hold the relative rôles of pupil and master.

Electrical Details of an Interesting Scheme.

This new spirit, which we feel is all for the good of the electrical industry in this country, was evident in the lecture recently delivered before the North Western Centre of the Institution of Electrical Engineers by Lieut-Col. F. C. Aldous and Mr. A. E. Leigh Scanes, and was still more evident in the discussion which followed the lecture. The lecturers set out to survey the position of electric power supply in the lower Rhine Valley and to give a general idea of the development that has taken place in that area during the past three years. It will be remembered that the district considered, which stretches approximately from Essen to Ahrweiler is ministered to as far as electricity is concerned by a company known as the Rhenisch Westfalisches Electricitätswerk. This company operates through a number of subsidiary companies and supplies three-phase current at the standard frequency of 50 to works and communes in its area and direct current to tramways. The transmission voltage is usually 25,000 volts, and the three-phase supply voltage 5,000 volts. The power stations are all interlinked and continuity of supply is ensured by the use of ring mains.

In this area, as in many others, both in Germany and in this country, the increasing demand for power necessitated the provision of more generating plant, and as far back as 1911 a large power station known as Goldenbergswerk was begun, which at the outbreak of war was in operation, one 15,000 kw. turbo-generator being installed. During the war this was considerably extended, and at the present time there are in addition five other 15,000 kw. turbo-alternators and two 50,000 kw. turbo-alternators, making the total capacity of the station 190,000 kw., which is something like a super-station.

Lignite *versus* Condensing Water.

The interesting feature about this station is not so much its size, but the fact that it is built right on the lignite fields, whence it derives its fuel. This arrangement was adopted as the low calorific value of that form of fuel, and the large quantity of water which it takes up, makes it necessary for about four or five times more fuel by weight to be burnt per horse power generated than if ordinary coal were used. Every advantage is taken at Goldenbergswerk of automatic appliances, the fuel being dealt with mechanically from mine to boiler in a way which a year or two ago would have made it a good example of the most modern practice, and even now the details of the plant as given by the lecturers are worthy of study.

There is, however, another side to the picture. A station of this size requires a very large quantity of cooling water, and at Goldenbergswerk this can only be obtained by the use of cooling towers. Not only does this necessarily reduce the efficiency of the plant, but those who argue that the use of this equipment also increases the fire risk of the stations will be able to justify their views by a reference to the fire at this place which destroyed about half the towers. The cause of the fire seems to have been the deposition of coal upon the woodwork of the towers and its ignition of the combination by sparks from a fire at another factory some distance away. It is also interesting to note that owing to the excessive hardness of the water the installation of softening plant was essential, as without it the tubes became almost invariably choked in about six months.

The Cooling of Alternators.

Those who agreed with and those who opposed Mr. Shepherd's views on the subject of cooling turbo-alternators which he put forward in his recent Paper before the Institution of Electrical Engineers will be interested to learn that at the Goldenbergswerk no excessively modern arrangements in this direction have been adopted. Air cooling is employed with both radial and axial ventilation, and the discharge is into the engine room. Those who think, however, that water cooling of turbines will reduce the fire risk will be interested to learn that this is looked after at this particular station by the use of compressed carbon dioxide, a system which the lecturers report works well and which was favourably commented upon in the discussions.

The Space Question.

A striking feature about the station is the amount of space allowed for the plant. And some engineers in this country will read with envy that there is ample room between the machines to remove the heaviest part and deposit it on the adjacent floor. This is a practice which might well be followed in this country, though the limitation of land which, as Mr. Dickinson pointed out in the discussion, is usual over here often makes this difficult. Nevertheless it is a point for consideration, as a case, such as occurred recently where the repair of a turbine rotor was greatly impeded because there was nowhere in the station to put it when it was lifted out of its place, is not much of a tribute to the way many of our stations are laid out.

The electrical gear in the station does not seem to present any great features of novelty except that the different phases of the 50,000 kw. generator switches which have been successfully tested to break a load of 100,000 kw. are not in separate chambers, so that a breakdown would be disastrous. It is also interesting to note that mercury vapour rectifiers similar to those described recently in our columns are installed in some of the sub-stations.

At the present time when electrical engineers generally are interested in the design and erection of large power stations Col. Aldous and Mr. Scanes are to be congratulated in bringing before us the details of this plant, which in many ways at least shows us what to avoid.

The Western Electric Co.'s Loud Speaking Telephone.

The requirements of modern civilisation are many and various. At one time, if announcements had to be made, the unaided human voice was considered sufficient, and if people could not hear what was said that was their look out. An advance—if such it could be called—was the invention of the phonograph; but this instrument has certain obvious disadvantages. The reproduction is accompanied by painful resonance effects even in the most modern machines, and a speech or an announcement cannot be quickly made to an audience—*i.e.*, a record has first to be taken. To electrical engineers the solution of this problem obviously lies in the employment of a loud-speaking telephone of some kind. By forcing up the transmission current the volume of the speech sounds received is also increased; but this is accompanied by a great deal of resonance and distortion, which detract from the quality of the sounds received.

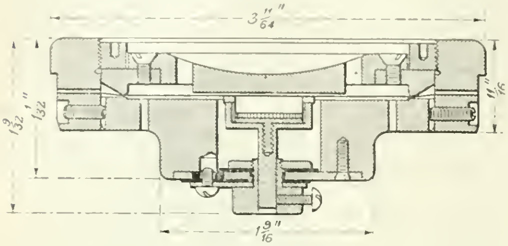


Fig. 1.

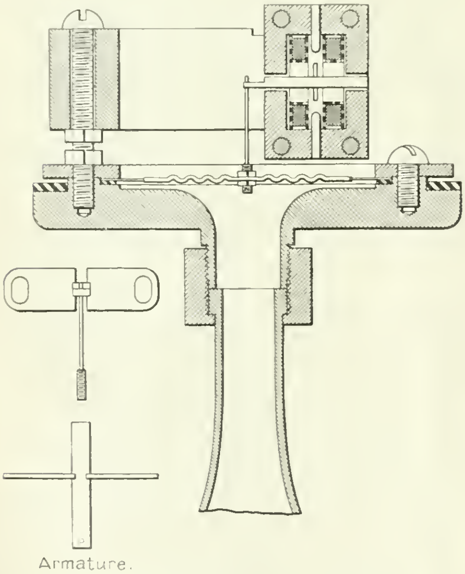


Fig. 2.

These difficulties seem to be successfully overcome in the loud-speaking telephone designed by the Western Electric Company which we inspected recently. In this equipment a specially designed transmitter, which is shown in section in Fig. 1, is used in connection with a battery of three electrode amplifiers, the arrangement employed being that shown in Fig. 3. These amplifiers may be said to be arranged in three stages, the first and second of which are voltage amplifiers and the third a power amplifier. In the first stage one valve is used, in the second two, while the number employed in the third depends on the number of receivers in use. Fig. 2 shows a section of the receiver used. Both receiver and transmitter have been designed to overcome resonance troubles. These receivers are fitted with horns similar to those used on gramophones, and for outdoor work, such as addressing large audiences or making announcements of the departure of trains, results of elections and football matches, are hung mouth downwards, as shown in Fig. 4. The battery described in the diagram as the high-tension battery has a voltage of about 240 volts, though this voltage and the capacity of battery, of course, depends on the number of receivers in use.

The demonstration of the capabilities of this arrangement was most effective. Newspaper extracts read by both a male and female employee were accurately and clearly reproduced to the small audience of Press representatives standing under the trumpets. In speaking for this purpose it is not necessary to stand very close to the transmitter, and the uncomfortable position usually necessary when speaking into an ordinary telephone need not, therefore, be assumed. A gramophone record and a pianoforte solo were reproduced, while the capabilities of the instrument for indoor work were also demonstrated.

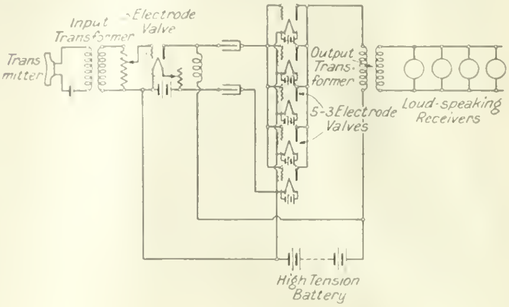


Fig. 3.

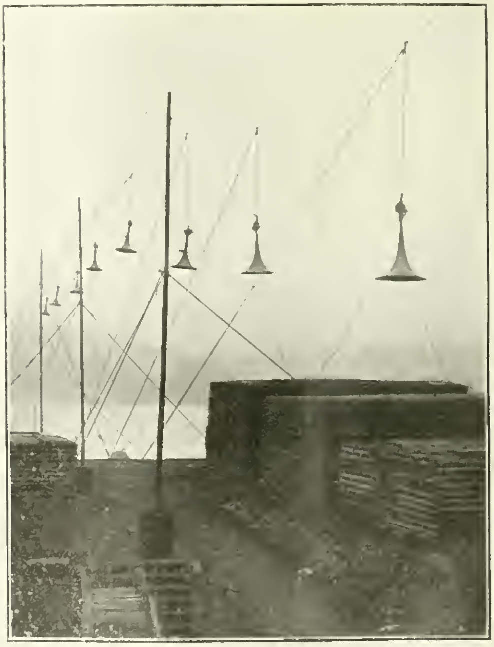


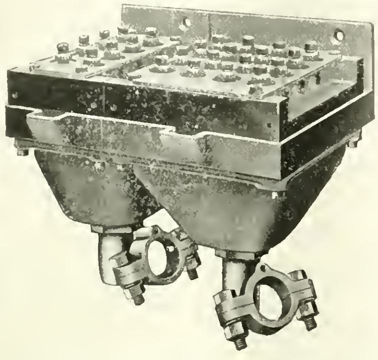
Fig. 4.

We understand the instruments shown are not yet on the market, but that their employment on certain special occasions has fully demonstrated their usefulness.

The Minister of Transport has extended for one year from Aug. 15, 1920, the period for the completion of the overhead equipment and other apparatus for working the trolley vehicles authorised by the Chesterfield Corporation Railless Traction Act, 1913, and by one year from July 8, 1920, the period limited by the Chesterfield Corporation Act, 1914, for the completion of certain tramways.

Horizontal Telephone Cable Dividing Boxes.

The operation of an extensive power system requires the services of an official, known in the United States as a load despatcher, but whose functions are really better described by the term load controller. From some central position he watches the load increase or decrease on the various sections of the network, and issues his orders accordingly. The duties of this official are likely to become more important and onerous as interlinking develops, and, in order that he may carry them out properly, an efficient telephone system is necessary. This factor introduces certain problems, one of which is the provision of a good mechanical arrangement of terminals in the dividing boxes to ensure easy testing and alterations. A solution of this problem is afforded by Messrs. A. Reyrolle & Company in their new horizontal telephone cable dividing box which we illustrate herewith. This is designed for dividing and sealing the ends of multi-core lead-covered cables, for leading off single cable tappings and making other connections. For accessibility, the terminals have been arranged in a horizontal plane, a sheet-iron cover protecting the terminals from dirt and dust.



View of Telephone Dividing Box with Cover Removed.

Although the normal working voltage is very low on telephone systems, it has been found by experience that ample clearances and good insulation between terminals is necessary to avoid interruptions of service which may otherwise be occasioned by abnormally high voltages, such as those induced by earth currents passing through the lead sheathing. These designs provide insulation sufficient to withstand the ordinary tests for 2,000 volt working. The terminals are provided with Ross-Courtney washers, which allow the wires to be readily disconnected and reinstated without impairing the contact.

It is frequently necessary to loop cable in and out of the sub-station, tappings being taken from some of the conductors to instruments in the sub-station. The design enables two or more of these boxes to be placed side by side. The terminal bases, forming as it were a flat table, is very convenient for bridging across connections from one box to another. Cross grooves are provided to allow for a neat lay of conductors. The ends of the multi-core cable are sealed in the ordinary way with dividing box compound.

Bradford Electricity Department.

The troubles of the Bradford Electricity Committee in regard to the supply of electrical energy have been successfully surmounted, thanks in a great measure to the efforts of the city electrical engineer (Mr. Thos. Roles), who reported last week that the largest turbo-generator, which broke down in October, had been repaired and had been running for a fortnight. When the breakdown occurred the winter load was in prospect, and the stoppage was a matter of grave concern. The Corporation was previously supplying the Yorkshire Electric Power Company with current up to 1,500 kw., and the company not only relieved them of that load, but also, at considerable inconvenience, gave the Corporation a load of 998 kw., while Shipley Urban Council supplied 495 kw. As it was expected that there would be a demand for 23,000 kw., and the maximum capacity of the plant available was only 12,900 kw. after the breakdown, it was decided to approach the masters and men of the textile trade, through the Industrial Council, and agreements were reached which would have been carried out in certain eventualities. If it had not been for the moulders' strike, there was no doubt that supplies to the textile and other consumers would have had to be curtailed. The engineering trades and the general body of consumers were also approached, and it was largely on account of the co-operation of all concerned that the department had been able to pull through. On the day after the repairs had been completed another generator became idle for about 48 hours. When the second generator was put right, on the day following, the weather was very foggy, and the plant carried the heaviest load it had borne during the winter. The Electricity Committee had now removed all restrictions as to the use of electric current, and in the near future they hope to have at work the first of two new turbines, each of 12,000 to 15,000 kw.

A social gathering was held in the Town Hall last week to celebrate the taking off of all restrictions, and to thank the Metropolitan-Vickers Electrical Company and the four employees of the company who had carried out the work continuously in 12-hour shifts. "I think," said Mr. Roles, "that in these days, when we hear so much about the unwillingness of employees to work, that we have an example here that all employees are not tarred with the same brush—and probably the majority of them are not. They were quite aware that unless these machines were being run the operatives in other trades would be greatly inconvenienced. I think that when men will give up their Christmas holidays and work right through it says a lot for the right feeling of those men. The Metropolitan-Vickers Company are to be congratulated that they have such men, and the men are to be congratulated that they are working for that company."

Mrs. Arnold then handed to each of the workmen (Mr. R. Lyson, Mr. P. Green, Mr. J. Jones and Mr. J. Foulds), on behalf of the Committee, a wallet containing Treasury notes.

The chairman of the Committee (Mr. W. Turner) said he did not think that any of the half a score of municipalities who had been in a position similar to—or worse than—that of Bradford had emerged so successfully. The Committee had that day passed a vote of thanks to the textile industry, as it was the first with which the Committee communicated when the breakdown occurred. They honoured those who voluntarily agreed to work "unearthly hours" if matters became worse. The same loyal spirit was shown by the engineering trades in accepting inconvenient and costly restrictions and also by miscellaneous power users. After endorsing Mr. Roles's remarks about the Metropolitan-Vickers Company and its workers, he paid a warm tribute to the efforts of Mr. Roles and his staff, and added that the greatest credit belonged to them and to the Committee responsible for the original acquisition of the plant. The machines were intended to have a capacity of only 3,000 kw., but they had been worked at 5,000 kw., so that they must have been maintained in a remarkable state of efficiency. Of the three remaining turbines when the breakdown occurred one was 10 years old, one 17 and the third 22 years old.

Mr. H. Mensforth, of the Metropolitan-Vickers Company, said that 95 per cent. of the working men in this country were sound and honest. If that were a fact, there was something wrong in the handling of men if 95 per cent. of efficiency was not obtained from them. It was the considered opinion of his firm that humanity was more essential than science or technical education.

The Electricity Supply Industrial Council.

A special meeting of the National Joint Board of Employers and Staff Members (Electricity Supply Industry) was held on the 6th inst. to consider matters referred to it by the E.P.E.A. The latter called the attention of the Board to the action of Poplar Borough Council in declaring that the E.P.E.A. was not a recognised Trade Union and instructing certain members of the technical staff of their undertaking to join the E.T.U. or the Municipal Officers Association. After discussion, the employers' side of the Board agreed to notify Poplar Council that they recognise the E.P.E.A. as a Trade Union duly registered, and a competent body to deal with matters affecting the technical staffs in the electricity supply industry; they were also of opinion that members of the E.P.E.A. in the employ of Poplar Council should be accepted as belonging to a recognised Trade Union.

The E.P.E.A. cited the case of the Bournemouth & Poole Electricity Supply Company, who had instructed one of their senior officers that he must resign his membership of the E.P.E.A. on the ground that "he could not sit on both sides of the table." The employers' side agreed to notify the company that the employers' side of the Board had decided that the members of the technical staff "up to and including the Deputy Chief Official" may quite properly be members of the E.P.E.A. As we understood that the duties of the officer (Mr. Goodyer) are such as to bring him within the above grades, no exception can be taken to his membership of the E.P.E.A.

The E.P.E.A. referred to the position of affairs at Stalybridge, and the evidence indicated that the Stalybridge, Hyde, Mossley & Dukinfield Tramways & Electricity Board, had (*a*) refused to institute a committee of inquiry into the dispute; (*b*) refused to refer the dispute to the employers' side of the National Joint Industrial Council; (*c*) refused to hear the representatives of the E.P.E.A. in connection with the dispute. The employers' side of the National Board agreed to urge the Minister of Labour to order an inquiry into the dispute. Representations were made to Board by the Ministry, but as the staff had been appointed no action was taken.

On the motion of the Minister for Works (Mr. Ball) the New South Wales House of Representatives in Committee decided recently that a Bill should be introduced authorising the Construction of Hydro-electric Works at Barren Jack, on the Tamut river and its tributaries, and on the Nymboeda river, with transmission lines, &c.

Commercial Topics.

Electrical Supplies for Netherland Indies.

According to reports there are good openings in the Netherlands East Indies for electrical goods and apparatus of all kinds, electric lighting sets, electrical fittings and accessories, incandescent lamps, machinery and tools for planters, aluminium, &c. In pre-war days the Germans supplied most of the machine tools, a good deal of the electrical plant, &c., and it should pay our manufacturers and exporters to devote some attention to the growing requirements of this market.

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Export of Electric Radiators and Cooking Apparatus.

There is an increasing demand for electric heating and cooking apparatus in the countries of South and Central America, in India, in Shanghai and the Far East, and the reports to hand show that there is great difficulty in getting goods, especially British supplies. We hope, therefore, that British manufacturers and exporters will bestir themselves and endeavour to capture these expanding markets while time and opportunity favour them. The British Consul at Colon recently reported that the Commissary Department of the Panama Canal was experiencing difficulty in obtaining electric grills and irons from the United States owing to the abnormal demands received by manufacturers, particularly for electric irons, during the past year.

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Germany's Financial and Export Problems.

The Valuta Commission which is carrying out investigations on the financial and commercial position of Germany has made a number of recommendations for the purpose of improving the exchange rate, developing exports, &c. It is suggested that electricity should be taken as a substitute for coal and as a means of decreasing the import of paraffin oil and motor spirits whenever possible, especially by utilising water power and by the erection of high-tension transmission lines. It is pointed out that "the only thorough measure for a continued improvement of our economic conditions, and of the Valuta, is to encourage home production, which necessitates increased work by the whole nation." Steps are to be taken—through the press or authorities—to enlighten the public on this point. The present decrease of home production is attributed to the insufficient coal supply and the bad rationing of coal as a result of transport conditions. The question of opening new coal fields is to be taken into consideration with a view to obtaining an increased production of brown coal.

Some of these recommendations might very well be taken to heart in this country, where the demand for shorter hours and other causes militate against increased output.

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Encouragement of Invention.

It is well known that inventors are a poorly rewarded but a highly beneficial section of the community. Owing to the nature of their work it is difficult to establish an effective organisation for their protection and consequently the benefit of inventions is frequently reaped by the manufacturers who undertake to exploit patents. Two or three partial attempts have been made to establish an organisation for the protection and exploitation of the ideas of inventors in this country, but nothing effective has so far been done. In the United States we learn of a movement to establish a National Laboratory Foundation for Invention and Research by independent endowments of wealthy men and large industrial firms, which would be made self-supporting by charging a percentage on the inventions of inventors which the laboratory will help to develop and market. Financial aid would also be given to poor inventors. The scheme for the creation of the Foundation has been prepared by Mr. Thomas Howard, Executive Chairman of the National Institute of Inventors, which has a membership of nearly 3,000. We think that similar work might be undertaken by an association or organisation which would be representative of the various research associations which are being formed in this country.

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British Publicity Methods in South Africa.

The senior trade Commissioner in South Africa (Mr. Wickham), who deals in a memorandum in the Board of Trade Journal on publicity methods for reaching local markets, lays stress on two points. The first is, that if goods need advertising in order to obtain sales, then the manufacturer must see to it that they are advertised. Many merchants do not care whose goods they sell; they will always give preference to those which sell most readily, and these are generally those which are most freely advertised. It is the manufacturer who profits most by the sale of his own goods; it is he who knows their intrinsic value and their selling points. In Mr. Wickham's opinion the cost of advertising, whoever pays it in the first instance, is in the end partly borne by the consumer. If distribution is properly organised and goods are properly put before the consumer, it is the ultimate cost to the consumer and not the f.o.b. or ex-factory cost on which the demand and turnover depend. The second point is that the outlay on advertising should never be based on existing sales, but on potential sales. Advertising to produce future sales is in the nature of capital expenditure. To keep the cost of advertising strictly within the bounds of what the existing turnover will bear, to expect to pay for it out of the profits on present sales, is to miss the whole point and aim of advertising.

Mr. Wickham also recommends that emphasis be laid on genuine selling points, such as quality, durability and suitability for that market and not to expect to sell goods merely by harping on the fact that they are British made.

Electricity Supply.

LONDONDERRY Corporation has increased its charges for electric lighting by 50 per cent.

BARROW Corporation has applied for sanction to borrow £35,000 for cable extensions for transformers, switchgear, &c.

LINCOLN Corporation has authorised a further increase of 15 per cent. in the charge for electric current.

The salary of the SOUTHWARK borough electrical engineer, Mr. D. M. Kinghorn, has been increased from £400 to £745 per annum.

The salary of the PONTYPRIDD electrical engineer (Mr. J. Teasdel) has been increased to £650 per annum, rising by annual increments of £50 to £800.

PORTRUSH Urban Council has arranged with the Belfast Bank for two loans in connection with its electricity scheme of £10,500 and £4,500 respectively, repayable in 25 years.

BARKING Urban Council has instructed the electrical engineer (Mr. W. Holmes) to enter into negotiations with the West Ham, East Ham and Ilford electricity undertakings in regard to a bulk supply for next winter.

HARROGATE Corporation have followed the example of Southend Corporation and have purchased two 600 B.H.P. Diesel engines taken from captured German submarines, for their electricity works.

SALFORD Corporation has decided to apply for sanction to a loan of £144,344 for additional generating plant, cable extensions, &c., in order to meet the demand for electrical energy next winter. A sum of £47,340 is for generating plant and £42,000 for boiler-house plant

COLWYN BAY Urban Council recently entered into an agreement with the North Wales Power & Traction Company for a bulk supply of electricity, and the construction of the overhead transmission line has been commenced. Llandudno Council is also negotiating for a bulk supply.

The salary of Mr. R. B. Leach, borough electrical engineer of LOUGHBOROUGH, has been increased to £550 per annum, as and from Jan. 1, 1920. Mr. Leach also holds the appointment of Local Fuel Overseer under the Household Fuel and Lighting Order for the Corporation of Loughborough.

The accounts of the LIVERPOOL ELECTRIC SUPPLY DEPARTMENT for the year ended Dec. 31 show revenue £629,539, and working and general expenses and special charges amounted to £416,773, leaving gross profit £212,766. Interes required £70,452 and sinking fund £60,477, leaving £81,836, of which £50,000 has been contributed to relief of rates, and the remainder placed to renewal fund.

BLACKBURN Corporation has accepted a report of the electrical engineer (Mr. P. P. Wheelwright) as to the advisability of providing a second generating set of 10,000 kw. at the new electricity generating station at Whitebirk. A special sub-committee also recommends that mechanical soot blowers be fixed to all boilers required for the two 10,000 kw. generating sets.

Owing to the rapidly increasing demand for electrical energy in HAMMERSMITH, the Borough Council are advised by the electrical engineer (Mr. G. Gilbert Bell) that further extensions are urgently needed. Subject to the consent of the Electricity Commissioners, it is proposed to instal a 7,000 kw. turbo-generator, with auxiliary plant, at a cost of about £60,000, and to extend the main distributing system in certain districts at a cost of £21,693.

In a report on the recent fault on an old feeder cable at ST. ANNES-ON-SEA the electrical engineer (Mr. J. H. Clothier) states that faults of the character in question are due to the method originally adopted of laying mains. The risk of damage to lamps might be reduced if consumers saw their circuit fuses were properly graded. "Bottle wire, bell wire, strips of copper and hairpins are all very well for an emergency, but in time of stress the lamps suffered from lack of proper protection."

On Tuesday the LONDON COUNTY COUNCIL sanctioned loans for electricity supply extensions to Poplar, St. Pancras and Stepney Borough Councils. In the case of Poplar, a loan of £68,060 was granted, subject to outstanding loans of £11,580 on displaced plant being accounted for. Of the St. Pancras load of £4,685, a sum of £3,406 is for building work (repayable in 30 years), £518 for machinery (15 years) and £761 for house services (12 years). The Stepney loan of £116,500 is for a 5,000 kw. turbo-alternator and two boilers, and the period of repayment is 15 years.

The Mayor of PRESTON (Councillor Parkinson) is an enthusiastic advocate of the industrial applications of electricity. At last week's Corporation meeting he said: "I believe we shall see the time when factory chimneys in Lancashire will be pulled down and every mill and workshop be supplied with electricity." This statement was made in reference to the Government's scheme for a super-power electricity station on the Ribble banks. Electricity, he said, was coming into its own and would be the power of the future. The Government having fixed Preston as a suitable centre, the foundations of a station will be commenced this year, near Bull Nose, where a huge dam will be erected. Sufficient electricity will be provided to supply power not only for tramways, but for every industry, lighting and heating. There will be sufficient plant to supply Preston, Lytham, St. Annes and Fleetwood in the West; Blackburn, Burnley, Accrington, Nelson and Rossendale Valley in the East; and Bolton, Rochdale, Heywood, Bury.

Practically all houses which are being erected by municipal authorities are to be wired and fitted for electric lighting. We have already recorded many decisions in favour of electric lighting, and last week SHEFFIELD Corporation decided that the 184 new houses on the Walkley Hall estate were to be wired, at an average cost of £10 per house, current to be supplied by the Corporation through meters.

Electric Traction.

Darlington Electricity and Light Railway Committee is considering the question of extending the tramway from Greenbank to the N.E.R. Stooperdale Offices.

The Railway Commissioners states that the electrification of the St. Kilda (Melbourne) suburban railway has resulted in an increase of at least 20 per cent. in the traffic.

Burnley Tramways Committee recommend the purchase of five single-deck tramcars and the construction of two sidings and pits . The Ministry of Transport is to be asked to sanction a loan of £19,732 for the work.

As a result of a local inquiry, the Peterborough Electric Traction Company has been authorised to charge passengers 1½d. per mile for the first two miles, and 1d. a mile beyond, with a minimum of 2d. for any distance over half a mile. For workmen's cars the charge will be 1d. a mile up to two miles, and a halfpenny for any mile or part of a mile in addition.

An increase in fares is contemplated on the tramways of the Stalybridge, Hyde, Mossley & Dukinfield Tramways & Electricity Board on account of the great increase in working costs. Last year there was a loss of £3,000 on the tramways, and it is estimated that unless there is an increased revenue that the loss next year will reach £10,000 and £11,000.

We are glad to learn that, as a result of negotiations between the employers' and workmen's sides of the Joint Industrial Council of the Road Transport Industry, the claim of the tramway and other workers for an advance of 10s. a week in wages has been referred to arbitration by the Industrial Court. The threatened strike in the industry has thus been averted.

Negotiations are proceeding between local authorities in Yorkshire and Lancashire for the inauguration of a system of transport which will enable one to travel from Leeds and Bradford to Liverpool by Tramcar or Omnibus. Motor vehicles will link up Hebden Bridge and Sandbed. Halifax will extend their trams to the Hebden Bridge boundary, where Todmorden motor omnibuses will meet them, thus completing the route.

The proposed reconstruction scheme of Blackpool Corporation tramways Committee will involve an expenditure of over £300,000. The re-laying of the track, of which practically three-fourths needs attention, is estimated to cost £254,343, this including the doubling of the line between Dickson-road and the Gynn, and in addition it is proposed to spend £52,177 on new works, or a total expenditure of £306,520.

The accounts of Halifax tramways department for the year ended March 31, 1919, show receipts £149,827 (compared with £129,680 in previous year), working expenses were £111,757 (£87,610), and, after providing for interest, sinking fund and income tax, the net profit was £10,767 (£16,837). Revenue was 19·43d. (16·65d.) per car-mile, and working expenses, including power, were 14·49d. (11·25d.). Passengers carried were 24,516,973 (22,822,341) and car-miles run 1,850,513 (1,869,357).

The Ministry of Transport has decided to appoint a Committee to inquire into the question of the Electrification of Main-Line Railways, and to advise the Ministry as to the practicability or otherwise of proposed schemes. The composition of the Committee has not yet been decided upon, but until it has reported, various schemes, including the proposed electrification of the North-Eastern Railway between York and Newcastle, will be held up.

Reports upon the financial position of the L.C.C. Tramways were presented to the County Council on Tuesday by the Finance and Highways Committees. Owing to the increased wages of employees, the rise in the price of materials, and other financial burdens imposed upon the tramways, the Council was recommended to authorise a new and increased scale of fares. Reports upon the subject were presented by the Highways Committee in July and December, 1919, and it is now stated that the receipts will be £212,215 less, and the working expenses £106,540 more than was estimated for 1919-20. The receipts per car-mile were 9·50d. in 1914-15, and the working expenses 6·89d., but in 1919-20 the receipts will be 18·87d. and the expenses 16·54d., so that while the receipts increased 111·07 per cent., the expenses advanced by 154·46 per cent. The Committee's report also contained the memorandum which was submitted to the Advisory Committee on London Traffic of the Ministry of Transport, and as it is considered unlikely that any material change will take place in the present financial position of the tramways, the Council were recommended to suspend the fares adopted in April last and to introduce the following scale for ordinary fares: 1d. for 1·2 miles, 2d. for 2·4 miles, 3d. for 3·6 miles and 4d. for any further distance (continuous journey on one car).

The workmen's fares will be 1d. single and 2d. return (without transfer) for 2·4 miles, 2d. single and 4d. return (without transfer) for 4·8 miles, and 3d. single and 6d. return (including transfer facilities as now given for 2d. single and 5d. return tickets) for any further distance.

The proposals of the Committee aroused considerable discussion and resulted in an all-night sitting of the Council. Among those who took part in the debate were: Mr. H. H. Gordon, Sir John Benn, Mr. J. D. Gilbert, M.P., the Rev. J. Scott Lidgett and Mr. W. J. Squires, chairman of the Committee. The objection to the Committee's recommendations was mainly based on the insufficiency of the facts and figures submitted, and it was urged that further consideration should be given to the question before increasing the fares. The Committee's report and recommendation were, however, ultimately adopted by 44 votes to 36.

Imperial and Foreign Notes.

Kyneton (Victoria) Shire Council propose to establish electricity supply works.

The scheme for the electrification of the Barbados Tramways, which was held up owing to the war, is to be revived.

A committee of residents of Stansbury (S. Australia) has been formed to deal with a scheme for lighting the township electrically.

The revenue of the Victorian Railways Department for 1918-19 was £6,432,277 from the railways and £43,798 from the two electric tramway systems, and the net deficit on the whole undertaking was £163,597. It is not expected that the electrification of the suburban railways will be completed before the end of next year.

The city of Seattle has provided for the disposal of foodstuffs by the erection of a large electrically operated cold storage and ice plant. The refrigerating plant machinery consists of three 110-ton ammonia compressors, each belt driven by a 150 h.p. 380 revs. per min. Westinghouse wound-rotor motor, and a 7½-ton ammonia compressor used as a pump-out machine, driven by a 7½ h.p. 580 revs. per min. motor. The auxilliary compressor permits work to be done on any one coil without the use of one of the large machines. The three 150 h.p. motors are controlled by what might be termed a semi-remote control, consisting of a magnetically-operated contactor connected in series with the motor switches. The contactor is controlled through a push button switch, located at the motor controller near the machine. The controller and contactor control circuit are inter-connected to avoid the closing of the primary circuit of the motor with a short-circuited rotor. An automatic master relay is provided for each machine to prevent excessive ammonia pressure, which is so connected as to open the contactor when the pressure reaches a pre-determined value. A number of auxiliary push buttons are also connected into this circuit and located conveniently to the main valves, so as to afford a ready means for shutting down the compressors instantly, if desired, from these points. Thirty-six 1 h.p. motors are used to drive centrifugal blowers for discharging air into as many rooms, located six on each floor. In addition to furnishing refrigeration for a seven-storey building, the plant also serves a 100-ton ice plant, from which ice is furnished at wholesale.

Telegraph and Telephone Notes.

During the past few days experiments in wireless telephony have been carried out by the Marconi Wireless Telegraph Company, and wireless amateurs in the neighbourhood of London have had the opportunity of listening to some interesting conversation. We hope to be able to publish a technical description of the apparatus used in a subsequent issue.

The Handley Page passenger aeroplane, which left London for Paris on the 4th inst., with six passengers, a crew of three and with a load of freight, was fitted with a Marconi wireless telephone, and a spoken message was received from it when over the Channel at 1.45 p.m., that the machine had just passed another Handley Page aeroplane flying from Paris to London. This is the first time that a practical application of Marconi telephones has been made on the London-Paris Handley Page air service.

The "Telephone Engineer" announces that the first commercial installation of the multiplex system of telephony invented by Major General G. O. Squier will shortly be in operation between New York City and Albany. Ths system was described in The Electrician at the time of its invention in 1911. Improvements in details have since been made, and it is now claimed that 10 and possibly more conversations may be held at the same time over a single line. The principal difficulty in very long distance telephony has been the uneconomical size of the conductors required. By the use of the Squier high frequency method this disadvantage is overcome.

Recently there have been again complaints of delays to cables to and from the Far East. The Eastern Telegraph Company explain that the delay during the past two or three weeks is due to lines being down. There was continuous interruption on the Great Northern route and lines were still down. The Indo-European system was practically unworkable. Owing to the breakdown of the American Pacific cable connecting the United States of America with the Far East, the whole of the American traffic for that part of the world had to pass over the Eastern and Associated Companies' systems. The American cable, as well as the British Pacific Cable between Australia and Canada, which was also interrupted, had been restored and matters would therefore improve. The cable companies have already laid two new cables, one connecting England with Gibraltar and the other between Malta and Alexandria. The cable ship which completed the last section will at once begin loading up a new cable to be laid between Aden and Bombay. This work, it is hoped, will be completed by the middle of May. New cables will also be laid this year between Gibraltar and Malta and between Madras and Singapore, which should have the effect of greatly improving the times of transmission. The companies believe that with these new cables and the installation of new automatic perforating instruments, they will be able to give a really good service. Telegrams are now, on an average, twice as long as they were in 1913. In that year the Eastern and associated systems dealt with 64 million words; in 1919 with 180 million words.

In addition the Post Office is proceeding with the erection of two high-power wireless stations to provide a trustworthy wireless service between this country and Egypt.

Miscellaneous.

We regret that Fig. 2 in our description of the Works of the Chloride Electrical Storage Company, which appeared on page 221 of our issue of Feb. 27, was described as the wood-working shop. The correct title should be the plate moulding department.

The profit on the reception, supper and dance, held in Newcastle on Dec. 12 last, has resulted in £50 being sent to the funds of the Electrical Trades Benevolent Institution. This is in addition to £118 7s. collected as subscriptions and donations by the Organising Committee.

Apparently the Electrical Trades Union will not allow cable jointers to connect up the supply mains to any installation erected by a plumber or non-unionist. Blackburn Council, which has been notified of this decision, decided to bring the matter to the notice of the Joint Industrial Council.

The Social Club connected with Pope's Electric Lamp Company, Ltd., Hythe-road, Willesden, held an enjoyable whist drive and dance at the Leopold-road schools, Harlesden, on the 3rd inst., about 450 of the staff and workpeople being present. The prizes were presented by Mrs. F. L. Pope, who, with Mr. Pope, Mr. E. A. Marx (Sales Manager) and Mr. Stanley Carman (Works Manager), joined in the proceedings.

We are informed that the Industrial League and Council have opened new offices at 82, Victoria-street, London, S.W.1. This organisation, it will be remembered, is an amalgamation of the Industrial Reconstruction Council, which was formed to assist in creating Whitley Councils, and the Industrial League, which was formed in 1914 as an organisation working on behalf of the cause of common humanity to establish industrial harmony.

The directors of Waygood-Otis, Ltd., entertained the senior members of the staff at dinner at the Trocadero on the 17th ult., and on the 28th ult. a reception and concert took place at the London Scottish headquarters to welcome back employees of the company who joined H.M. Forces for the great war. Among the company of about 600 were Messrs. H. C. Walker (chairman), D. W. Green and Clarke (managing directors), R. H. Thorpe, H. Harmsworth and C. H. J. Day (directors), and over 200 men (the guests of the evening) who have seen service during the war. The musical and variety entertainment which was given reflected great credit on the organisers. Printed with the programme was a Roll of Honour containing the names of 49 employees who have given their lives for their country.

A grand concert, followed by a whist drive and dance, was held at the Borough Hall, Greenwich, on the 3rd inst., by the staff and employees of Messrs. Elliott Brothers (London), Ltd., of Lewisham. Including friends, about 500 were present. The arrangements were made by an organising committee consisting of members of the "Elliott" Social Association. The concert was admirably arranged by Mr. Raymond O. Smith, secretary to the company, who also conducted the "Century Works" Orchestra, which rendered delightful selections from well-known composers during the evening. The vocalists were Miss D. Mackay Webster, Miss Helen Sola, Mr. Leslie Wissler and Mr. Ben Lawes, a member of "The Follies." Monologues were given by Mrs. R. O. Smith. At the conclusion of the concert refreshments were served, after which those who wished to dance adjourned to the small hall. The whist drive was held in the large hall, about 45 tables being occupied. Mr. L. W. Smith (a director of the company), who also distributed the prizes, was M.C., assisted by Mr. W. F. Beaden.

Business Items, &c.

Mr. A. P. Trotter, of Messrs. Handcock, Dykes & Trotter, is retiring from the firm as from March 25, but will continue to give attention to his special subjects in engineering and science from his new address, Greystones, Teffont, Salisbury, Wilts.

Messrs. Murray Coombs & Richards (A. Murray Coombs and A. F. W. Richards), advising and inspecting engineers, have removed from 25, Victoria-street, Westminster, S.W. 1, to Cross Key House, 56, Moorgate-street, London, E.C.2. Telephone: London Wall 9,080.

We regret to learn that owing to the continued ill-health of Mr. D. A. Brown, consequent on his service in the East during the war, he has been ordered by the doctor to live abroad for some years, and the partnership between Mr. Harold Couzens and himself has accordingly been dissolved. Mr. Harold Couzens will continue to practice as a consulting engineer at 9, Old Queen-street, Westminster, S.W.1, as heretofore.

After 21 years' service, Mr. D. G. Brooks severed his connection with Simplex Conduits, Ltd., on Oct. 31 last. He opened a branch for the Company in Glasgow, and was subsequently appointed Manager in London, but shortly was transferred to the head office and works in Birmingham. For nearly 14 years he held the principal position in the Simplex Company under the Directorate. He has now joined forces with the Walsall Hardware Manufacturing Company, and will take up their sales direction over a large portion of England, Wales and Scotland.

Mr. E. P. Bennett has been appointed secretary and sales manager of the Simplex Conduits, Ltd., Garrison-lane, Birmingham. Mr. Bennett, who has held a number of positions in the company, including that of Manager for Liverpool and also for London and the South of England has had a long experience in the electrical business, both in England and America, and was connected with some well-known contractors both in London and the provinces prior to his engagement with the Simplex Company. During the war Mr. Bennett held a technical commission in the R.A.F., but on the cessation of hostilities he undertook an extended tour, covering most of the European countries, in order to study the possibilities of the markets for electrical commodities.

Institution Notes.

Mr. Thomas T. Heaton has been awarded the Thomas Hawksley Gold Medal for 1920 for his Paper on "Electric Welding." This medal is given annually by the Institution of Mechanical Engineers for the best Paper published in the "Proceedings" of the preceding year.

The Papers read at the joint meeting of the Faraday Society and the Rontgen Society on April 20, 1919, when a general discussion took place on "The Examination of Materials by X-Rays," have now been published in book form. They form a useful record of the work that has been done on this important subject.

The proceedings of the American Institute of Electrical Engineers is now called "The Journal," and is issued in a new and larger form, measuring 12 in. by 9 in. It will contain, besides papers read before the Institute, a large amount of information of interest to members both in the technical articles and in the advertisements

The annual report of the Institute of Metals, which was presented at the annual general meeting held on Wednesday and Thursday of this week, shows that the activities of the Institute have been well maintained. The remarkable increase in membership which took place in 1917 has not spent its force, and the net increase during 1919 was 127. The membership on Dec. 31, 1919, was 1,213, as compared with 640 on the same date in 1915. A large amount of useful work is still being carried on by various committees, including that on corrosion research, of which the fifth report has just been issued. It is proposed to increase the subscription rather than to curtail the substantial advantages gained by members. A number of interesting Papers were read and discussed at the meeting.

Mr. G. S. Baker, who presided over the half-yearly council meeting of the National Union of Scientific Workers on Saturday, reported that the rapid growth of the union had necessitated the appointment of a full-time secretary, and the executive had appointed Major A. G. Church, B.Sc., D.S.O., M.C., to fill the office. The report of the Research Committee referred to the functions of the Committee and of the Research Council which is to be elected. Dissatisfaction was expressed with the action of the Department of Scientific and Industrial Research in sanctioning a recent appointment. It was considered that the State should not subsidise research associations unless they displayed an anxiety to ensure that the direction of research should be in the hands of qualified scientists who had shown capacity for leadership in research work. In a report on "Patent Rights," presented by Mr. A. A. Griffith, M.Eng., of the Royal Aircraft Establishment, the opinion was expressed that the only satisfactory way of remunerating salaried inventors was to pay them adequate salaries, and that they should have no claim to extra payment because their work proved unexpectedly remunerative.

The 42nd annual general meeting of the Institute of Chemistry was held on Monday, when Sir Robert Robertson, Vice-President, occupied the chair in the absence through illness of Sir Herbert Jackson, the President. In moving the adoption of the Report of Council, Sir Robert read the President's address, in which reference was made to the position of professional men under prevailing economic conditions. In order to secure better remuneration and conditions of appointment chemists were urged to do all in their power to render themselves prepared for such opportunities as came their way. The Institute was ready to help them to secure suitable appointments and endeavoured to encourage the employment of the competent. The roll of the Institute was steadily increasing, numbering nearly 3,000 Fellows and Associates and over 500 Registered Students. The Council were engaged in remodelling the bye-laws, providing for district representation on the Council, and revising the regulations for admission to membership. The Officers and Members of Council for the year 1920-21 were elected. The President is Sir Herbert Jackson, K.B.E., F.R.S.; and the Vice-Presidents are: Mr. Horatio Ballantyne, Sir James J. Dobbie, LL.D., F.R.S., Mr. Ernest M. Hawkins, Mr. Gilbert T. Morgan, D.Sc., F.R.S., Sir Robert Robertson, K.B.E., F.R.S., and Mr. George Stubbs, O.B.E.

Obituary.

We regret to announce the death of Dr. Henry Smith Carhart, which took place at Pasadena, Cal., on the 12th ult. Dr. Carhart, who was born in Albany County, New York, on March 27, 1844, graduated in 1869. In 1873 he became professor of physics in the North Western University at Evanston, and in 1886 he was appointed professor of physics in the University of Michigan, at Ann Arbor. It was here that his best work was performed; here he designed and established the first physical laboratoty, and later he developed the electrical engineering department of the University. He was one of the international jurors of award for the United States at the Paris Exposition of Electricity in 1881, and afterwards he took a course of study and experimental work in the Helmholtz laboratory at the University of Berlin. The result of which was the production of a standard cell for the measurement of electromotive force. Dr. Carhart did much useful work in the United States for the advancement of the teaching of physics; he served on several committees, and for a time acted as secretary of the Association on standards of measurement. Prof. Carhart was a frequent and valued contributor to the technical journals, including The Electrician; he was the author of several well-known text-books, including "Primary Batteries," "University Physics" and "Electrical Measurements." He was one of the official delegates to the International Electrical Congress in Chicago, and was President of the Committee of Judges of Award in the department of Electricity for the World's Fair. Dr. Carhart, who relinquished teaching some years ago, was well-known in this country, and his lovable disposition endeared him to all who had the pleasure of his acquaintance.

Educational.

At a meeting called by the Chancellor of the University of Cambridge (Mr. A. J. Balfour, M.P.) and the President (Sir J. J. Thomson, O.M.) it was resolved to raise a fund for a Memorial to the late Lord Rayleigh. The memorial will probably take the form of a window in Westminster Abbey, but the committee, which was appointed for the purpose, will also have under consideration the possibility of providing an additional memorial of a scientific character.

Prince Arthur of Connaught will preside over a luncheon, to be given on Thursday next at the Savoy Hotel, when the proposals for the reconstruction and the re-equipment of the Engineering Laboratories at University College (London) will be explained by the treasurer, Sir Ernest Moir, and others. It will be remembered that an appeal for £100,000 towards this object was recently issued, and already over £33,000 has been collected. It is urgently necessary that the whole fund should be subscribed by June in order that the buildings may be put in hand. Donations should be sent to his Royal Highness Prince Arthur of Connaught, at 42, Upper Grosvenor-street. Among the engineering firms who have recently responded to the appeal are Messrs. Babcock & Wilcox, £500; City of London Electric Light Company, £250; St. James' & Pall Mall Light Company, £250; Rolls-Royce, Ltd., £100.

Personal and Appointments.

Sir James Dewar has been elected a corresponding member of the French Academy of Science.

The late Lord Rayleigh left unsettled property of the gross value of £172,972, with net personalty of £172,245.

Lieut.-Col. H. C. Fraser, D.S.O., has been appointed Superintendent of Organisation for the Yorkshire Electric Power Company.

Mr. R. L. Horsfield, of Walsall, has been elected tramways manager of the Cardiff City Tramways, in succession to Mr. Arthur Ellis, who recently resigned. Mr. C. G. Morley New, A.M.I.E., deputy engineer, Cardiff, has been promoted to the position of city electrical engineer in succession to Mr. Arthur Ellis.

Sir Henry Haward, Controller of the London County Council, having been appointed one of the Electricity Commissioners, the General Purposes Committee recommend that Sir Henry be allowed to resign from the Council's service with a superannuation allowance of £1,206 3s. 7d. a year.

Mr. John Terry, operative superintendent of the London County Council Tramways, retired on the 2nd inst., after 40 years' service on London tramways. Mr. Terry was entertained at a concert, at which a presentation was made by Mr. A. L. C. Fell, general manager. In reply, Mr. Terry referred to the long working hours when he joined the service, and also to the tremendous development since 1880. During the week ending Oct. 16, 1880, the London Tramway Company ran 70,196 miles, carried 542,664 passengers and earned £3,224 8s. 7d. During the week ending Feb. 18, 1920, the London County Council tramways ran 1,066,765 miles, carried 13,042,095 passengers and earned £78,089 8s. 4d.

Consequent upon the appointment of Mr. E. T. Goslin as general manager and engineer of the Clyde Valley Electric Power Company, the Glasgow Corporation Tramways and Conditions of Service Committees recommend that Mr. George G. Braid, A.M.I.C.E., be appointed deputy chief engineer of the department at a salary of £800 a year, and Mr. James Macdonald, chief electrical assistant, at a salary of £500. Mr. Braid, who is a native of Edinburgh, began his engineering training in 1893 with Messrs. Duncan Stewart & Company. Five years later he was appointed technical engineer in the Post Office, and in 1901 he became assistant engineer of the Corporation Tramways Department as assistant engineer. At the end of 1902 he was chosen chief electrical assistant, from which position he has now been promoted to deputy chief engineer.

Catalogues, Price Lists, &c.

The General Electric Company, 67, Queen-street, E.C.4, has issued new Osram billheads (invoice forms) and post cards and will be pleased to supply them to the trade with a number over-printed with their name and address. The Osram matter is concise and to the point—the well-known "Arm and Clouds" design in colours being attractive.

We have received from Messrs. Simplex Conduits, Ltd., a copy of their new advance catalogue. This special issue is made pending the completion of their full list. The present section deals with Simplex conduits, fittings and accessories, and in these features is particularly comprehensive. It has the advantage over most similar trade catalogues in that there is a fair amount of descriptive matter dealing with the various accessories to the system, which makes the book rather more than an ordinary price list, and certainly improves its usefulness.

We have received from the British Thomson-Houston Company a copy of their new price lists dealing with lighting fittings for street and industrial interiors, and for ships, mines and chemical works. These fittings are specially designed for use with the half-watt lamp. For every pattern and size of B.T.-H. lantern manufactured there is a complete set of data and curves available showing its exact performance, and by means of coefficients it is possible to find the illumination given by each unit at the pavement level—say at any point between two standards. All the fittings are of substantial weatherproof and rust-proof construction, with adequate provision for ventilation, and are so designed as to reduce to a minimum the time necessary for cleaning and renewals.

Tenders Invited and Accepted.

Dunedin (N.Z.) Council require tenders by April 26 for electric car bodies, car trucks and equipment. Specifications from the Town Clerk.

Bedford Corporation electricity department invite tenders for year's supply of meters and cables. Tenders to Town Clerk by noon, April 3.

Eccles Electricity Committee require tenders by 10 a.m., March 15, for supply of two 500 k.v.a three-phase alternating current transformers.

Edinburgh Corporation require tenders by March 29 for structural steel work of the new Portobello generating station.

Durham Guardians want tenders by March 18 for wiring the Poor Law Institution, 37, Crossgate, Durham, for electric lighting. Particulars from the Master.

West Ham guardians require tenders by March 25 for six months' supply of electrical fittings, ironmongery, &c. Forms of tender from the Clerk, Union-road, Leytonstone, London, E.11.

Manchester Electricity Committee require tenders by noon March 19 for d.c. switchgear for Dickinson-street generating station. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Ormskirk Guardians require tenders for the supply of a 40 kw. 200-volt d.c. steam-driven generating set. Specifications, &c., from Mr. G. J. Gibbs, 7, Lune-street, Preston.

Rhondda Council want tenders by noon March 31 for one year's supply of a.c. meters, cable joint boxes, compound, cut-outs, &c. Specifications, &c., from the Engineer, Electricity Works, Porth, Glam.

Bristol Guardians require tenders by noon March 22 for electric light wiring and fitting at Eastville Institution. Specification from Mr. H. T. Sully, Scottish Widows'-building, Baldwin-street, Bristol.

Mountain Ash Council require tenders by March 20 for transformer plant, h. and l.t. switchgear, armoured cable, overhead line material, &c. Specifications from the Engineer, Electricity Department, Ynysbwl, near Pontypridd.

The Secretary to the Tender Board, Public Works Department, Wellington, N.Z., will receive tenders until noon, June 30, for electrical equipment for the Arthur's Pass Section of the Midland Railway. Specifications from the Head Office of the Department, Wellington, N.Z.

The City of Melbourne invites tenders for the supply of 12,000 metal filament lamps. Specifications from the agents of the City Council, Messrs. McIlwraith, McEacharn & Company Ppty., Ltd., Billiter-square-buildings, London, E.C. 3, to whom tenders by noon March 30.

The Deputy Postmaster-General, Brisbane, requires tenders by noon, March 22, for instrument parts, &c., for the Australian Commonwealth Postmaster-General's Department. Patterns can be seen at the offices of the High Commissioner, London, and of the Controller of Stores, Brisbane, Sydney, Melbourne, Adelaide, Perth and Hobart.

Gellygaer Urban Council invite tenders for the supply of transformer plant and h.t. and l.t. switchgear for substations, also a quantity of 11,000 volt and 500 volt overhead line material. Specifications from the resident engineer and manager, Bank Chambers, Bargoed, and tenders to the clerk, Mr. Frank T. James, by March 21.

The Great Central Railway Company invite tenders for 12 months' supply of various stores and materials, including electric line construction material and apparatus, wires and cables, lamps, &c. Specifications from Mr. Walter Williams, Gorton, and tenders to the secretary, Marylebone Station, London, N.W., by March 17.

Aberdeen Corporation has ordered two boilers from the Stirling Boiler Company at £41,000.

Swansea Electricity Committee has accepted the tender of Messrs. Ed. Bennis & Company (at £1,210) for an elevator capable of raising 20,000 tons of coal per hour and delivering same to a chain conveyer.

Burnley Council is recommended to accept the tenders of the British Thomson-Houston Company for five tramcar electrical equipments and of the English Electric Company for five single deck bodies. The construction of the car trucks will be undertaken by the tramways department. The electrical equipments will cost £936 10s., the bodies £1,350 and the trucks £1,060 each.

York Corporation received six tenders (ranging from £52,331 to £107,388) for the erection of the hydro-electric power house at Linton Locks. The lowest tender—a composite one from Messrs. Vickers Ltd. and Timothy Patrick—provides for turbines of the high velocity type, and is recommended for acceptance, subject to the electrical engineer (Mr. J. W. Hame) obtaining satisfactory guarantees as to the efficiency and power of the turbines. Eight tenders were sent in for the supply of cables, ranging from £8,807 to £9,950, and the Electricity Committee also advise acceptance of the lowest—that of Messrs. Vickers.

Bankruptcies and Liquidations.

The discharge of Ernest Bohm, electric lamp manufacturer, 5, Boxworth-grove, Barnsbury, London, N., has been granted.

A meeting will be held at Central House, Finsbury-square, London, E.C. 2, on March 29, to receive an account of the winding-up of the Enfield Electric Cable Mfg. Co., Ltd.

F. Husband, Ltd., is being wound up voluntarily, and Mr. R. S. Farries, 8, Laurence Pountney-hill, Cannon-street, London, E.C., has been appointed liquidator.

A meeting to receive an account of the winding up of Bonecourt Surface Combustion, Ltd., will be held on March 30 at the registered office of the company, Parliament-mansions, Victoria-street, S.W.1.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

114.632 Siemens & Halske Akt-Ges. Electrical measuring-apparatus. 27 3 17
115.241 Ges. für Elektrische Industrie. Coin-freed telephone call-box. 25 5 14
115.242 Ges. für Elektrische Industrie. Coin-freed telephone call-boxes. 19 3 17.) (Addition to 115.241.)
120.902 Scintilla. Rotating magnets of magneto-electric ignition apparatus. 6 11 17.
120 917 Dufaux. Direct-driven electric lighting apparatus for cycles and other road vehicles (16 11 17.)
121.471 Hulfish. Automatic telephone systems. 8 12 17.)
137.553 Benjamin. Electrolytic apparatus. (1 8 17.)
137.564 Br[illegible]ham. Deutsch M. Production of high frequency electric currents. (19 12 18.)

Comprises a transformer, means for varying currents therein, said means comprising a coil and connections for enabling said means and said transformer to be operated by either direct or alternating current wherein whilst all of the turns of said coil are in circuit for direct current the connections comprise a tap in circuit with a part of said turns for alternating current.

137.876 Partridge & Smith. Electric valve amplifiers. (13 11 18.)

1919 Specifications.

122.642 Schwank. Supportinginsulators for electric high-tension conductors. (21 1 18.)
123.[illegible]78 Splitdorf Electrical Co. Method of and apparatus for generating ignition current. (9 11 17.)
124.756 Vell[illegible]. Electric lamps. (23 3 18.)
125.948 Schaub & Kunzli. Electric signalling apparatus for cars on electric and other railways. (23 4 18.)
129.259 Garbarini. Electric arc-incandescent lamps. (3 7 18.)
130.614 Bethenod. Methods of indirectly coupling a radio-telegraphic antenna to a high frequency alternator. (30 7 18.)
131,582 Ter Kuile. Electric weft feeler arrangement for weaving looms. (23 8 18.)
132,233 Mancha Storage Battery Locomotive Co. Storage battery locomotive. (31 8 18.)
132.519 Mauron. Automatic regulation of the parallel working of variable-speed dynamos and accumulators. (10 9 18.)
132 779 Ritsema. Insulating caps for electrical joints. (18 9 18.)
132.782. Weid Van Der. Electric-lighting apparatus for cycles and motor cycles. (19 9 18.)
133.318 American Bosch Magneto Corporation. Electric ignition apparatus. (1 10 18.)
133.673 Adam. Electric lighting fixtures. (8 10 18.)
135.825 Alexanderson. Means for cooling dynamo-electric machines. (26 11, 18.)
136.406 Stalhane & Kring. Electric soldering-irons. (11 3/19.)
136.436 International Electric Co. & Baldock. Electric selective switching apparatus. (14 8 18.) (Divided Application on 126.755.)
136.439 Arnold & Belling. Socket tubes for electrical connectors, wall sockets, and the like. (12,4 19.)
136.463 Johnsons & Phillips & Tracey. Whipping for telephone and telegraph cables. (23 5, 19.)
136.494 Tsukamoto & Kabushiki Kaisha Tsukamoto Denki Kenkyusho. Signal system for telephones. (9 7 19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

October 27.

26,267 Wilcox. Junction, &c., device for wiring systems.
26,278 Byford & Harris. Electric engine-starter.
26,279 Balbi. Thermo-electric instrument.
26,326 Corradi. Electrolysing water.
26,332 Armour Fertilizer Works. Production of aluminium intride, &c., by electrically generated heat. (10 7/19, U.S.)
26,333 Smits. Electric heating. (5.5 19, Holland.)
26,347 Sykes Interlocking Signal Co. & Tarrant. Controlling transmission of electrical impulsion.
26,348 Cutler. Electric water heaters.
26,350 Gill. Controlling devices for electric engine starters.
26,352 Brush Electrical Engineering Co. & Sutton. Turbo-electric driving.
26,356 Alexanderson & Nexdorff. High frequency alternators. (6 12/18, U.S.)
26,363 Brewerton, Fraser & Rankin. Hand-operated rotary switches.
26,374 Round. Telephone transmitters.

October 28.

26,415 Illingworth. Cut-outs.
26,420 Davies. Maintaining tramcar lights while changing trolley pole.
26,433 Hands. Holders for electric lamps.
26,435 Shaw. Lamp holders.
26,454 Railing & Taylor. Electric conduit systems.
26,470 Uno. Recovering selenium, &c., from electrolytic slimes. (28/10/18, Japan.)
26,478 Harcourt. Switches.
26,485 Audran. Electric apparatus for controlling pianos, &c. (18/7/19, France.)
26,487 B.T.H. Co. (G.E. Co.) Motor starters.
26,488 Alexanderson. High frequency alternators. (4,11/18, U.S.)
26,493 Jones. Magnetos, dynamos, &c.
26,495 Murray & Standisn. Electric light fittings.
26.496 Allmanna Telephonaktiebolaget, R.M. Ericsson. Selective switching devices. (11/12/18, Sweden.)

October 29.

26,522 Sanford. Insulator bridge troughing.
26,525 Somers. Baring ends of electric conductors.
26,542 Galloway. Magnetic reflector.
26,548 Glanville. Alternating current dynamos for lighting.
26 578 Lambert. Electrical device.
26,596 Cracoann. Multiple fuses for conductors carrying high voltages. (27 5 19. Germany.)
26,620 Angell. Electric motors.
26,621 Rohman. Electric lighting, &c., of railway carriages.
26,626 Smeekens. Electric lighting for advertising, &c. (18,2/16, Belgium.)

October 30.

26,634 Merryweather. Electrically operated pumps.
26,663 Dean & Redmayne. Electric furnaces.
26,715 Westinghouse Electric Mfg. Co. Electric switching. (30/10, 18, U.S.)
26,721 B.T.H. Co. (G.E. Co.) Motor controllers.

October 31.

26,755 Meade. Prevention of tapping in intercommunication telephone systems.
26,767 Parker. Switches for low tension currents.
26,776 Wilson. Electric control apparatus.
26,802 Automatic Telephone Mfg. Co. (Automatic Electric Co.) Coin freed prepayment devices for telephone systems.
26,815 Plowman & Rogers. Motor starters and generator controllers.
26,816 Collier. Diaphragms for telephones, &c.
26,837 Fairburn. Conductor arrangements of traction systems.

Companies' Reports, &c.

London Supply Companies.

The directors of the Brompton & Kensington Electricity Supply Company, after appropriating £8,181 to depreciation and reserve, propose a final dividend on the ordinary shares at the rate of 17 per cent. per annum, making 12 per cent. for the year, carrying forward £1,230.

At the meeting of the Notting Hill Electric Lighting Company, Ltd., on Tuesday, the directors reported that the capital expenditure was £261,760, or £55,408 in excess of receipts. The cost of the joint station at Wood-lane amounted to £231,686. From the available profit of £32,753 had to be deducted: depreciation renewal and reserve fund (£3,000), special reserve (£3,000), debenture interest (£1,792), Kensington & Notting Hill joint debenture stock interest (£1,903), interest on loans (£293), sinking funds (£1,573), income-tax (£5,433), amount to be distributed to staff under co-partnership scheme (£356), leaving £15,405. A dividend on the ordinary shares of 8s. per share (less tax) was declared and £1,783 carried forward. Mr. Arthur E. Franklin has been elected chairman.

The profit of the Chelsea Electricity Supply Company, Ltd., for the year 1919 amounts to £33,037, which with £1,106 brought forward and £2,324 for interest, makes a total of £36,467. After deducting interest on debenture stock (£5,480), interim dividend on the preference shares at rate of 6 per cent. per annum (£900) and interim dividend on the ordinary shares at rate of 3 per cent. per annum (£3,708), the balance is £26,379. The directors recommend that £16,688 be placed to credit of reserve for renewals, &c., £1,089 be written off cost of extinction of founders' shares, and that a final dividend on the preference shares at rate of 6 per cent. per annum, making 6 per cent. for the year (£900), and a final dividend on the ordinary shares at rate of 5 per cent. per annum, making 4 per cent. for the year (£6,179) be paid, leaving to be carried forward £1,523. The number of 8 c.p. lamp equivalents is 345,527, an addition of 5,593 during the year, and the total number of units sold was 4,224,505, a decrease of 266,033.

The total capital expended by the South London Electric Supply Corporation, Ltd., at Dec. 31 was £481,490, the amount expended in 1919 being £9,210. The balance of revenue, after deducting generation and distribution costs, rates, taxes, wages, &c., was £40,879 10s.,and with amount brought forward and interest on investments, &c., the amount available is £46,258. Deducting interest on mortgage debenture stock, amounts carried to depreciation (£8,000) and to general reserve fund (£2,500), and amounts written off leasehold account and issue expenses of debentures (£667), the balance for distribution is £28,210. Interim dividends were paid on the 6 per cent. cumulative preference shares and at rate of 4 per cent. on the ordinary shares for the half-year ended June 30, and it is proposed to pay a further dividend on the preference shares (payable April 1) and a further dividend on the ordinary shares for the half-year ended Dec. 31 at rate of 8 per cent. per annum (making 6 per cent. for the year), leaving £10,810 to be carried forward. The applications received during the year were equivalent to 2,351 kw., making the total 18,083 kw. The units sold were 7,565,639, an increase of 453,387 units.

The report of the Metropolitan Electric Supply Company, Ltd., for the year 1919 states that the capital expenditure is £2,396,921, an increase during the year of £53,806. The gross revenue for the year was £413,059, compared with £348,726 in 1918, and the working expenses amounted to £242,623 against £208,112. The directors have set aside £69,486 to depreciation and reserve fund, and, after writing off balance of discount and expenses on issue of debentures of £21,845, the fund now stands at £525,000. The amount carried to credit of net revenue account is £100,951, which, together with balance brought forward, interest, &c., makes a total of £119,510. After deducting interest on debenture stocks and dividend on preference shares, the balance is £64,441. An interim dividend of 1s. per share (at rate of 2 per cent. per annum) on the ordinary shares capital, amounting to £10,000, was paid in August, and the directors now recommend a further dividend of 5s. per share (10 per cent. per annum) on such shares be now paid, making a total distribution for the year of 6s. per share, or 6 per cent. This will absorb a further sum of £50,000 and leave £4,441 to be carried forward. During the year new connections, representing 2,867 kw., were added, making a total connection of 45,426 kw.

Addressing the shareholders of the South Metropolitan Electric Light & Power Company last week, Mr. H. St. J. Winkworth said that the business had been well maintained during the year. The total horsepower connected was 28,596, an increase of 2,419 over 1918, a good proportion of which was due to extension orders from existing installations. 479 new consumers were connected, against 51 in 1918, making the total 7,641. The protracted moulders' strike seriously affected the demand for electricity. The number of units sold was 15,642,716, compared with 23,633,862, the decrease being entirely accounted for by a reduction in bulk supply, but that demand was steadly recovering. Owing to the falling off in bulk supply, to a modification in the rate of charge to ordinary consumers, and to an increase in the lighting demand, the average price had risen from 1·58d. to 2·47d. The receipts from sales of current (£155,531) were practically the same as those for the previous year, and the total receipts were £166,996, compared with £167,233. Coal cost £59,951, against £72,897, the reduction being due to the smaller output. The total expenditure amounted to £96,887, or 58 per cent. of gross receipts, compared with 62 per cent. The business of the West Kent Electric Company had been adversely affected by the reorganisation of works and factories from war to peace requirements. There were now gratifying signs of recovery. After a reference to the Electricity (Supply) Act, he said there was a marked activity in all sections of their business—power, heating and lighting, and installation work showed a steady growth.

The report of the County of London Electric Supply Company, Ltd., states that the capital expended during 1919 amounted to £130,043, and the net total expenditure at Dec. 31 was £2,440,181. With £15,516 brought forward, the total revenue for the year was £232,989. Deducting interest on first and second debenture stock, &c. (£44,177), amount written off preliminary expenses (£5,000) and the amounts carried to reserve for depreciation, &c. (£50,000), and to general reserve (£45,000), the balance for distribution is £88,812. The interim dividends on the six per cent. preference and the ordinary shares for the half-year ended June have absorbed £26,876, leaving £61,936. The directors now recommend a further dividend on the preference shares, and on the ordinary shares at the rate of 11 per cent. per annum, making 8 per cent. for the year on the ordinary, and leaving £19,188 to be carried forward.

The opinion is expressed that the electricity Supply Act should be of material assistance in connection with the development of the Electricity Supply Industry of the country and should assist in solving the question of London electric supply. Mr. C. P. Sparks resigned the position of Engineer-in-Chief to the Company at the end of 1919. Mr. A. R. Bacon has been appointed chief station engineer and Mr. J. D. Dallas, Chief Mains Engineer. The applications received during the past year amounted to the equivalent of 8,532 kw., making the total 82,224 kw. The total units sold were 42,487,672, an increase of 2,161,409. The number of consumers increased from 28,400 to 31,390.

The report of the Charing Cross, West End and City Electricity Supply Company, Ltd., states that the gross earnings of the West End undertakings from sales of current, rents, &c., during 1919 were £265,856 (against £193,858), and the expenses were £167,242 (132,946), the net earnings being £98,614 (£60,912). Adding £142 brought forward and £5,056 for interest the total available is £103;832. After providing for interest on debenture stock (£17,829) and setting aside for depreciation £22,000, the balance is £64,003, out of which has been paid the preference dividend shares for the year, £18,000, and an interim dividend at rate of 2s. per share on the ordinary shares (£8,000), leaving £38,003. The directors recommend a final dividend on the ordinary shares at rate of 5s. per share (making 7 per cent. for the year), absorbing £20,000, that £10,000 be carried to general reserve, leaving £8,003 to be carried forward. The equivalent of 775,563 (30 watt) lamps is connected to the mains (lighting 459,809, heating 80,777, and power 234,977.

The gross earnings of the City undertaking from sales of current, rents, &c.; were £331,323 (£238,075); the expenses were £273,722 (£199,250), and the net earnings £57,601 (£38,825) with £9,075 from 1918 the total available is £66,676 after providing for interest on debenture stock, &c. (£31,458), the balance is £35,218, out of which has been paid the preference dividend (£18,000), leaving £17,218. The directors recommend that £10,000 be transferred to general reserve, and that £7,218 be carried forward. The equivalent of 851,515 (30 watt) lamps is connected—334,925 in lighting, 120,323 in heating, and 396,267 (15,936 h.p.) in power.

An interim dividend of 2s. per share (tax free) has been declared by the Globe Telegraph & Trust.

The proposed exchange of shares between Brunneb, Mond & Company, Ltd., and the Castner-Kellner Alkali Company, Ltd., has been ratified.

The directors of Bruce Peebles & Company, Ltd., have declared a dividend at the rate of 7½ per cent. per annum (less tax) on the ordinary shares for the year 1919, payable March 31.

The directors of the General Electric Company, Ltd., announce that the list in respect of the issue of the preference and ordinary shares closed on Tuesday, the required capital having been over-subscribed.

The directors of Vickers, Ltd., announced final dividends for 1919 of 2½ per cent. on the preference stock and on the preference shares and cumulative preference shares, payable on the 25th inst.

The directors of the British Aluminium Company, Ltd., have decided to make a distribution out of the reserves by means of the issue of two fully-paid ordinary shares for every three ordinary shares now held.

The directors of the Metropolitan-Vickers Electrical Company, Ltd., recommend payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum to Dec. 31 last.

The transfer books of the Western Telegraph Company, Ltd., will be closed from the 17th to the 24th March inclusive, preparatory to paying on the 25th inst. an interim dividend of 5s. per share (tax free) for the year ending 30th June, 1920.

The net profit of Messrs. Clarke, Chapman & Company, Ltd., for 1919 was £146,466. A dividend of 7 per cent. on the preference and 2s. 6d. per share on the ordinary shares are recommended. A sum £20,000 is to be placed to reserve and £74,973 carried forward.

The directors of the British Insulated & Helsby Cables, Ltd., have declared a dividend of 8¾ per cent. (actual) on the ordinary shares, making 12½ per cent. for 1919 (as in 1918), and a bonus of 2½ per cent. A sum of £105,000 has been placed to depreciation account and £103,000 carried forward.

During 1919 the number of consumers connected to the mains of the Rushden & District Electric Supply Company, Ltd., increased from 179 to 223; £950 was added to depreciation fund and £300 written off preliminary expenses. A final dividend of 8 per cent. (making 6½ per cent. for the year) was declared and £355 forward.

It was reported at the meeting of the Llanelly & District Electric Lighting & Traction Company, Ltd., on Monday, that the available profit, including £2,058 brought forward was £17,659. After providing for debenture stock redemption (£1,072) and general reserve and renewals (£4,000) a dividend on the ordinary shares of 7 per cent. for 1919 (less tax) was declared and £3,016 carried forward.

The report of the directors of the Telegraph Construction and Maintenance Company, Ltd., states that the net profit for 1919 was £124,184, and with £110,296 brought forward the total is £234,480. Deducting the interim dividend of 2½ per cent. paid in July last £22,410, a sum of £212,070 remains to be dealt with. Of this sum the directors propose to distribute a further dividend of 7½ per cent. (tax free), absorbing £67,230, to supplement the reserve fund by £20,000 (making it £140,000), and to transfer £10,000 to the pension fund, leaving £114,840 11s. 5d. to be carried forward. The general business of the company during the past year has been satisfactory, and works and steamships have been maintained in their usual state of efficiency.

The capital expended by the Bournemouth & Poole Electricity Supply Company, Ltd., during 1919 amounted to £9,473, making the total £508,563. With £1,299 brought forward, the total available for distribution is £38,573. Deducting interest on debenture stock, &c. and the amount carried to reserve for depreciation, the balance is £20,641. Interim and final dividends have been paid on the 4½ per cent. and 6 per cent. preference shares, and an interim dividend on the ordinary shares at the rate of 5 per cent. per annum, which leaves £8,303, out of which the directors recommend a final dividend on the ordinary shares at the rate of 7 per cent. per annum for the half-year ended Dec. 31 (less tax), making 6 per cent. for the year, leaving £4,628 to be carried forward. The total applications are equivalent to 14,291 kw., an increase of 1,695 kw. The total number of units sold was 4,680,347.

Addressing the shareholders of the North London Railway Company last week the chairman (the Hon. A. H. Holland-Hibbert) said that although they could not hope to obtain in the future the same measure of prosperity which they used to enjoy before omnibuses and tramways searched out every corner where traffic was possible, they still possessed a valuable property which they hoped would become increasingly valuable when the London and North-Western Railway were able to compete the electrification of the line from Queen's Park to Camden Town. A certain amount of patience was required with regard to electrification, but some progress had been made. In spite of the increase in fares passenger traffic had increased by 25 per cent Evidently passengers were realising the great comfort of their really good electric trains. For 1919 they would pay a dividend of 3¼ per cent., which, with the interim dividend, made 5½ per cent. for the year.

The income from investments of the Underrgound Electric Railways Company of London, Ltd., for the year 1919 was £680,125 (decrease of £68,031) and the total receipts were £692,364 (decrease of £67,901). The expenditure was £101,758. Adding balance brought forward (£36,693) and deducting interest on the 4½ per cent. bonds, the 5 per cent. three year secured notes and the 6 per cent. first cumulative income debenture stock, &c., the available balance is £384,656. Three per cent. was paid on the 6 per cent. income bonds in June, and it is now proposed one per cent., leaving a balance of £22,939. The Metropolitan District and the London Electric Railway Companies have, between them, ordered 140 additional carriages, and jointly ordered an additional 15,000 kw. turbo-alternator for the Lots-road generating station. A new subway is being constructed at the Charing Cross station. The London United and the Metropolitan Tramways Companies have reconstructed considerable portions of their tracks, and the London United Company has overhauled its rolling stock. The greater part of the address of Lord Ashfield to the shareholders at the meeting last week was devoted to justifying the proposed increase of fares. He said the income from their holdings in the different companies of the group amounted to £680,000, a reduction of £68,000 compared with 1918. The Metropolitan District, the London Electric Railways and the London General Omnibus Company all paid reduced dividends. The expenditure (£101,758) showed an increase of over £20,000. They could only pay 4 per cent. on the income bonds. The result was as disappointing as it was unexpected. In the first six months of 1919 the gross receipts of the operating companies increased faster than the expenses, but in the second half-year expenses increased much faster than the gross income, and he regretted to say that since the close of the year expenses had continued to rise. After dealing with the work of the allied companies, he denied that their capital was watered. The Underground Company made it possible for the operating companies to build and equip the London Electric Tube Railways and electrify the District Railways. For that great public service the shareholders had not received a single penny in dividends. If those railways had to be built to-day it would cost more than twice their present capital to build them. There were essential improvements needed, the estimated cost of which was £6,000,000, but until the position was altered it was hopeless to contemplate raising such a sum as that. London urgently needed entirely new underground railways, including at least one (probably two) high-speed lines. The crucial question was not construction and location, but how the money was to be raised. The associated companies were promoting two sets of Bills—for extension and improvement works and for the increase of the maxima now fixed by statute for fares. Having summarised the reasons for the increase, he said they were asking for power to charge 2d. per mile. They had no intention of charging the maximum fare, but only sufficient to adjust their charges on a fair basis.

New Companies.

ALADDIN (LANCASHIRE & YORKSHIRE), LTD. (163,948).—Private company. Reg. Feb. 11, capital £50,000 in £1 shares. Objects: to acquire exclusive licences for the working in the Counties of Lancashire and Yorkshire of the patents belonging to the Aladdin Renew Electric Lamp Corporation, and to enter into certain agreements. Permanent directors: E. J. McWilliam and J. C. McIntosh.

AMOS & WALSH, LTD. (164,244)—Private company. Reg. Feb. 19, capital £3,000 in £1 shares, to carry on the business of metal merchants, solder manufacturers, dealers in machinery and electrical plant, &c. Reg. office: 22, Kingsland-road, Shoreditch, N.E.

ANERLEY ENGINEERING WORKS, LTD. (164,245)—Private company. Reg. Feb. 19, capital £500 in £1 shares, to carry on the business of electrical and general engineers and contractors, &c. First directors are E. Harrison, G. Harrison and E. Reyd. Reg. office: 97, Anerley-road, S.E.20.

BALLINROBE ELECTRICITY SUPPLY COMPANY, LTD (1,907).—Private company. Reg. in Dublin Feb. 13, capital £5,000 in £10 shares, to carry on the business indicated by the title. Directors are: Rev. E. A. Dalton, P. D. Daly, M.D., T. Fitzpatrick, T. M. Scott and J. B. Staunton. Secretary: J. B. Staunton. Reg. office: Abbey-street, Ballinrobe, Co. Mayo.

BRITISH SCIENTIFIC APPARATUS MANUFACTURERS, LTD. (164,339)—Private company. Reg. Feb. 21, capital £3,000 in £1 shares, to carry on publicity and propaganda with a view to introducing, making more widely known and increasing the sale of articles manufactured by members, to acquire showrooms and display scientific apparatus of British manufacture, to promote export in British made scientific apparatus, instruments, &c. First directors are C. Beck, M. B. Field, F. C. Knowles, R. Miall and H. T. Tallack. Reg. office: 6, Moorgate-street, E.C.

CHARLES PARKER (LONDON), LTD. (164,067)—Private company. Reg. Feb. 14, capital £5,000 in £1 shares, to take over the business of manufacturing electrical engineers, magneto specialists, &c., carried on by C. C. Parker at 75, Park-road North, Acton, W. First directors are C. C. Parker (permanent managing director) and R. J. Hewett.

ELECTRIC FIRES, LTD (164,072)—Private company. Reg. Feb. 14, capital £10,000 in 4,000 10 per cent. cumulative preference and 5,900 ordinary shares of £1 each and 2,000 founders' shares of 1s. each, to acquire and turn to account inventions relating to electrical or other fires, radiators, stoves, &c. Life directors: C. H. Smith, 32, Parliament-hill, N.W., electrical engineer, and F. L. Newhouse, W. Runton, Norfolk.

R. CRANMER BROWN, LTD. (164,229)—Private company. Reg. Feb. 18, capital £5,000 in £1 shares, to take over the business of electrical, mechanical and general engineers, &c., carried on as T. P. Pollitt & Company, Ltd. First directors are H. H. King and R. C. Brown. Reg. office: 9, Wellington-street, Hull.

WEBB'S CRYSTAL GLASS COMPANY, LTD. (164,415).—Reg. Feb. 23, capital £750,000 in 700,000 shares of £1 each and 1,000,000 shares of 1s. each, to carry on the business of manufacturers, merchants, importers and exporters of glass, including electric lamp bulbs, tubing and rod, glassware for scientific and industrial purposes, &c. Directors are L. C. Hatry, S. N. Jenkinson, R. W. Johnston, C. Jackson, T. B. Kitson, F. L. Payne and F. W. Towle. Reg. office: 6, Austin Friars, E.C.

Prices of Metals, Chemicals, &c.

Tuesday, March 9.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£122 0 0	—	£5 0 0
Electro Wirebars...	,,	£124 0 0	—	6 0 0
H.C. wire basis......	per lb.	1s. 4⅝d.	—	$\frac{11}{16}$d.
Sheet..................	,,	—	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8⅝d.	—	$\frac{11}{16}$d.
Brass 60/40—				
Rod, basis	,,	1s. 0¼d.	—	⅝d.
Sheet, basis	,,	1s. 5d.	—	½d.
Wire, basis	,,	1s. 4½d.	—	—
Iron—				
Cleveland Warrants	per ton	£9 2 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£43 0 0	—	—
Lead Pig—				
English	,,	£52 0 0	—	£1 10 0
Foreign or colonial	,,	50 0 0	—	2 0 0
Tin—Ingot	,,	386 10 0	—	17 0 0
Wire, basis	per lb.	0 4 9	—	3d.

Salammoniac.—Per cwt. 95s. and 90s.
Sulphur (Flowers).—Per ton £22.
,, (Roll Brimstone).—Per ton £22.
Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £48.
Boric Acid (Crystals)—Per ton £74.
Carbon Bisulphide.—Per ton £56.
Sodium Bichromate.—Per lb. 9d.
Sodium Chlorate—Per lb. 5½d.

Rubber.—Para fine, 2s. 6½d.: plantation 1st. latex 2s. 6¾d. per lb
Shellac.—T.N. Orange, 805s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd.

Forty Years Ago.

(The Electrician, March 13, 1880.)

Electric Lighting.—The Jablochkoff system is to be continued in the streets of Paris till May, 1881.

Prize Essay.—A "Prix Vaillant" will be awarded this year for the best solution of the question "How to perfect the phonetic telegraph in some important particulars?" The memoirs should be handed in on or before June 1. The prize is founded on a bequest of 40,000 francs by M. Marechal Vaillant, and is given every two years.

Magnetising Steel.—From recent experiments made by Herr Holtz it appears that the magnetism of steel bars, magnetised during the process of hardening, is only conditionally superior to ordinary magnetisation, and that the superiority of magnetisation during hardening decreases where the magnetising force increases, where the thickness of the bar increases. It is greatest where, with weak magnetising force, the bar is at the same time partly withdrawn from the action of the means of magnetisation; and it is least where, with great magnetising force, a great thickness of bar is used.

A New Use for the Telephone.—Hitherto (says the "Scientific American") it has been a matter of some difficulty to determine the time of flight of small-arm projectiles owing to the impossibility of seeing them strike. In a series of experiments made by the U.S. Ordnance Department this difficulty has been overcome by the use of the telephone. The telephone was connected with two Blake transmitters, one placed near the gun, the other in front of and near the target. The time between the report of the gun and sound of the ball upon the target was measured by a stop-watch. The observations, founded on a large number of experiments, never differed more than a quarter or half of a second from each other, the slight delay in starting the watch being neutralised by the delay in stopping it. It was found that the time of transit was affected by the wind, being shortened by a rear and lengthened by a head wind.

The Siphon Recorder.—There is a relic of old student days in the laboratory of Sir William Thomson, at the Glasgow University, when the Siphon Recorder had just been born into existence. It is a parody on Tennyson's well-known lines, after the manner of Clerk Maxwell, entitled, "A Farewell" (by a telegraph clerk to the mirror galvanometer signal on the introduction of the "Siphon Recorder."):—

Flow up swift message from the sea,
Thy pregnant tale deliver;
No more on thee my eyes need be
For ever and for ever.

Flow, softly flow, by wire and key,
But move the mirror never;
No more on thee my eyes need be
For ever and for ever.

But here will rock the light coil free,
And here the siphon shiver;
And all of thee will tell to me
For ever and for ever.

A thousand dots may stream for thee,
A thousand dashes quiver;
But not on thee my eyes need be
For ever and for ever.

—J. M.

* * * *

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics":—Mr. Holt Thomas on "Aerial Transport"; "The Indian Air Mail," by F. A. de V. R..; and "Occasional Papers on Aeronautics, No. 1," by A. R. Low, F.R.Ae.S.

"Cabinet Maker":—"The Development of Small Folding Tables"; "Prices of Metal Bedsteads: 1914 and 1919 Costs and Profits Compared"; and "The Making of Welts in Leather for Upholstery."

"Chemical Age":—"Atomic Weights and Atomic Numbers," by Dr. Stephen Miall; "Methods for the Filtration and Softening of Water," by Dr. Hepburn; and further correspondence on "The Problem of Chemical Organisations."

"The Fruit Grower":—The Potato Order, 1920; "Diseases of Orchards" (Illustrated); and "Simplified Land Laws."

"The Gas World":—"Cause of the Caking of Sulphate of Ammonia"; "Demonstrations in Coal Saving and Gas Combustion," by George Helps; and "The Heat of Carbonisation of Coal," by C. Weyman.

"The Hardware Trade Journal":—"Standing Committee's Report on Investigation of Bedstead Prices"; "Labour Saving in the Foundry, V."; and "Sidelines."

"Ways and Means":—"Big Figures and Simple Facts," by The Editor; "The Economic Situation in France," by M. Roger Picard; "Some Aspects of the Financial Situation," by Sir George Paish; and "Municipalities and Industrial Development, XVI.—Cardiff," by J. Dockett Smith.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,183. [No. 12. Vol. LXXXIV.] FRIDAY, MARCH 19, 1920. PRICE ONE SHILLING. By Post, 1s. 1d. Abroad, 1s. 2d.

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Notes.

The Control of Trains.

To recommend control of any kind is not popular at the present time. There are, however, ways in which control can even now be successfully used, and among these, as we have often pointed out, the employment of some method whereby a train in movement can be checked or signalled to in moments of emergency has much to recommend it. This matter has been given fresh interest by reports recently issued by the Ministry of Transport on the causes of accidents at Selby, on the North Eastern Railway, and at Haverhill, on the Great Eastern Railway. In the one case it will be remembered a fast passenger train passed a home signal at danger, with the result that it ran into another train on a converging line, while in the other a passenger train collided with the buffer stops owing to the driver failing to apply the brakes in time. A somewhat similar accident at Crewe and other accidents with light engines at Streatham and Benton Bank would, in all probability, have been avoided had the driver been made aware of the operating conditions by some other methods than mere visual or verbal signals. As is well known, the former method is practically exclusively used for signalling both passenger and goods trains over open sections of line, but it is not, perhaps, realised how much such means as arm-waving and shouting through megaphones are employed in shunting and terminal movements of light engines. Seeing that is the case, the only wonder is that accidents do not more often occur at such places.

An Extension of Automatic Signalling.

WE do not wish to imply that automatic control of trains is non-existent. On the contrary, in the form of track circuiting it is largely used on many railways, but only in connection with visual signals. Indeed, it may be said that it controls the signalman rather than the engine driver—a useful function, but one which requires extension. The problem of how best to control the train or, what is the same thing, the engine driver, is not a new one, and has been more or less successfully tackled by a number of inventors, as a perusal of our columns any time within the last ten or fifteen years will show. But the railways have not yet seen their way to commit themselves to the large capital expenditure which a general installation of one of these systems would involve, and public opinion, though vocal on the occasion of serious accidents, has not been persistent enough to bring about the necessary change. The war has, of course, been an excellent excuse for dilly-dallying of all kinds, but now it is time something was done, and we hope that the Ministry of Transport will exercise its powers, and cause tests to be made of one or more of the several promising systems available. Before, however, these tests are carried out it must be decided exactly what the control is going to do. Is it simply to give the driver in the cab an audible indication to warn him he is approaching or has passed a signal at danger; or is it to apply the brakes and bring the train to a standstill without the driver's intervention? The latter system is, of course, successfully used on the Underground Railway of London, but, on the other hand, what is required on our main lines is not so much to bring the train to rest, but to ensure that an adverse distant signal will be respected by slowing the train. Those of a conservative nature will point out the numerous difficulties which will compass the adoption of any such system, but difficulties are meant to be overcome, and in any event the advantages to be gained by the elimination of accidents are worth more than a little to obtain. The public demand for a better train service, with the resulting reduction in headway, in many busy centres will also mean a reduction in the factor of safety, and any methods which will lead to an increase in the safety of the travelling public merit close examination, with a view to their early adoption.

The Institution and Its Council.

MEMBERS of the Institution of Electrical Engineers will shortly be called upon to elect a Council to represent their interests during the next twelve months. The statement is made in this particular way because representation of the members' interests should be the principal object of every Institution Council. In the past there has been a good deal of criticism at the composition of the Councils selected, not only collectively, but individually, but as Mr. J. SAYERS pointed out in our correspondence columns some weeks ago, the composition of any Council lies in the hands of the members of the Institution concerned, and if it is the desire of the members to have a vigorous and powerful council, it is their simple and obvious duty to nominate candidates possessing these qualifications, and, what is no less important, to vote for them when they are nominated. We hope, therefore, that not only this year, but every year, members of the Institution of Electrical Engineers will take a more active interest in a proceeding which gives them all reasonable power over the conduct of their own affairs, if they will only take the trouble to use it. That they should use this power is of great importance at the present time, when not only the electrical industry, but the whole country is passing through a period of transition. We want men on the Council who shall not only be representative technically, but commercially and politically as well. The criticism should no longer be that the traction or the telegraph interest is over or under represented. That is a relatively minor matter. What is of importance is whether the Council is so composed that it is likely to be of real influence not only in the industry, but among the greatest commercial and political interests. This can be done if the right Council, and particularly if the right president is selected. The choice of a president is indeed one which should be made with the greatest care, and we hope that when Mr. Roger T. Smith seeks a well-earned rest among the past-presidents, the appointment of a man possessing the qualifications we have outlined will receive the closest consideration.

The Tariff Question Again.

We shall be interested to see the result of the revised scheme of charges for electricity which has been compiled by Mr. H. Richardson, city electrical engineer of Dundee, for use in that northern burgh. It is not so many years ago since a discussion of the relative merits of various methods of charging led to a generation of heat far greater than the importance of the question merited. This is not to say that it had no merit at all. In those days, whatever may be the case now, it was advisable that the average price charged per unit consumed should be such that the receipts would be greater than the total expenditure, and it was equally desirable that no class of consumer should be charged at an unduly high rate while another class obtained their energy at less than cost. The law on the matter is clear. The price per unit must not be exceeded, and no consumer must receive preferential treatment over another in the same class. These fundamentals were, however, sometimes forgotten, though Mr. Trotter reminded us that the tariff might legally be based on the cube root of the number of a consumer's waistcoat buttons, so long as the total amount of his account divided by the number of units consumed did not exceed the statutory maximum of 8d. per unit. It has, however, been left for Mr. Richardson to suggest that a man should pay according to size of the room he occupies, by proposing a fixed charge of 2s. per 100 sq. ft. of living room per quarter plus ¾d. per unit plus 15 per cent. as a scale for domestic consumers, while in the case of shops the fixed charge will be 5s. per 100 sq. ft., the other charges remaining the same. The worst of any scientific system is that it is not always commercial. In this instance, a man who lives in a small high room, in a lift shaft, say, will have to pay less for his energy than a man who lives in a room like a lift shaft laid on its side; and if we are going to be quite equitable it is a little difficult to see why he should. Again, why should a shopkeeper pay a 150 per cent. greater fixed charge than a domestic consumer. We agree that their load factors are different, but surely they are not all that much different, nor does such a system encourage the use of heating and cooking apparatus in places where they can not only be employed efficiently but as an advertisement. The system, as far as we can see, possesses no advantages over those now in use, and its drawbacks cannot be overlooked.

The Ministry of Transport and the Electrical Industry.

The Ministry of Transport, with a super-man at the head, does not seem to be doing very well. The economically-minded are distressed at the Gargantuan character of its pay roll, and the public generally are wondering when they are going to get back those cheap, fast trains which conveyed them to Brighton and Southend during the summer months, and when they may expect to get their goods delivered within a few weeks of the time they are despatched. Electrical engineers have no reason to be less vocal in their criticism. Schemes of electric traction which would not only mean increased orders and production, but would bring about a much needed alleviation of the traffic chaos, are held up for consideration by a committee, which means that something will begin to be done on the eve of the Greek Kalends or thereabouts, and meanwhile neither will orders eventuate or travelling become more comfortable. Again, at a time when there is an ever-increasing demand for electricity supply there is an ever-increasing difficulty in obtaining coal. Accrington and Burnley, to take two examples, have been in sore straits, while a deputation to Sir John Snell from the London County Council and several of the Metropolitan boroughs pointed out that they had only four days' reserve supply of coal at their stations. And the answer was: Lack of transport. It is a black record for so young a criminal, but if the Ministry of Transport were being run by mere men we could perhaps suggest excuses for them. It is the predominance of all that is wonderful in its councils combined with a lack of anything approaching action in its procedure that we find so difficult to comprehend.

The Value of Scientific Records.

One branch of scientific work, laborious but often valuable, which is apt to be overlooked, is the keeping of systematic records of the performances of plant and appliances. The value of such records is recognised in many fields, for example in much central station work and particularly in the boiler house, but they might often be used with advantage in relation to outside installation work. We recall a device adopted by a French engineer some years ago, namely, the assembly of "contour cards" showing the exact load variations for every year in the form of a solid diagram, which deserves to be more widely known as it leads at once to broad conclusions which might be overlooked by mere inspection of a series of individual load-charts. Another instructive example of the value of records is afforded by some work recently published relating to the public lighting, by gas-filled lamps, of five parks in Chicago, in which some thousands of lamps were installed. For some years it has been the practice to record the date on which every lamp is installed, the time elapsing before its replacement and the period for which it has burned. In this country we have few published records of the actual performances of gas-filled lamps in practice on a large scale, though doubtless supply companies possess information of this kind in regard to lamps used for public lighting. The Chicago records proved useful in revealing various defects in circuits which curtailed the life of lamps and required to be remedied. But the most striking fact revealed was that the life of lamps apparently depended more on the number of times they were switched on and off than the actual hours during which they were burned. Information on this point was rendered possible by the fact that some lamps are burned on an all-night schedule, others for half-nights only, and others again alternately for a full night and a half-night. This affords a useful illustration of the unexpected information that may be derived from systematic records.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

Mr. A. Poulsen contributes an article on "The Localisation of High Resistance Breaks in Submarine Cables" (p. 312), in which he describes and discusses critically the relative advantages of the Siemens, Hockin and Schoenau-Gulstad tests.

On page 316 we give an account of a discussion which recently took place at Newcastle-on-Tyne on Capt. J. M. Scott-Maxwell's Paper on "Scientific Management: A Solution of Capital and Labour Problems."

An abstract of an interesting Paper on "Direction and Position Finding by Wireless Methods," recently read before the Wireless Section of the Institution of Electrical Engineers by Capt. H. J. Round, will be found on page 317.

On page 319 we give a short account of the first three of a course of six lectures which are now being delivered by Sir J. J. Thomson at the Royal Institution on "Positive Rays."

On page 320 we give an abstract of a Paper read before the Faraday Society on "Methods of Measuring the Magnetic Hardness of Ferrous Metals," by Mr. L. A. Wild.

On page 322 we give a short account of the exhibits of electrical interest at the International Motor Boat and Marine Engine and Stationary Engine Exhibition which is now being held at Olympia, London.

We give a description of a 32,500-k.v.a. Water Wheel Generator on page 323.

An account of the discussion which recently took place at a meeting of the Illuminating Engineering Society is given on page 325.

Our leading article deals with the present financial position of the London County Council Tramways (page 327).

On p. 329 we give an account of the exhibits of electrical interest at the London Fair and Market at the Agricultural Hall, Islington.

Suggested Home Office Regulations for electrical machinery on the pit-bank will be found on p. 329.

On p. 328 there is an abstract of the Report of the Sub-Committee appointed by the Standing Committee on Trusts to investigate the position of the Electric Lamp Industry.

Arrangements for the Week.

FRIDAY, March 19th (to-day).

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "The Indian Currency System and its Developments," by Sir William S. Meyer.

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "Exact Data on the Performance of Mechanical Stokers, as Applied to 'Lancashire' or other Narrow-Flued Boilers," by Mr. D. Brownlie.

N. East Coast Institution of Engineers and Shipbuilders.

6.15 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "Turbine Steels," by Dr. W. H. Hatfield and Mr. H. M. Duncan.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. At the University, Sheffield. Lecture on "Some Steam Economies," by Mr. G. Rowe.

8 p.m. At the Y.M.C.A., Bothwell-street, Glasgow. Lecture on "Oil Tankers," by Mr. C. R. H. Bonn.

Electro-Harmonic Society.

8 p.m. At the Holborn Restaurant, London, W.C. Smoking Concert.

SATURDAY, March 20th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, London, W. Lecture on "Positive Rays," by Sir J. J. Thomson, O.M., P.R.S. (Lecture V.)

Birmingham and District Electric Club.

6.30 p.m. At Grand Hotel, Colmore-row, Birmingham. Ninth Annual Dinner.

Institution of Electrical Engineers.—North Midland Centre.

7 p.m. At Royal Victoria Hotel, Sheffield. Joint Meeting with the Association of Mining Electrical Engineers. Paper on "Electric Winders," by Mr. D. Kerr.

MONDAY, March 22nd.

Institution of Electrical Engineers.—North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle-on-Tyne. Paper on "The Production of Power from Blast Furnace Gases," by Mr. S. H. Fowles.

Institution of Electrical Engineers.—Liverpool Students' Sub-Centre of the North-Western Centre.

7.30 p.m. At the University, Liverpool. Paper on "The Financial Organisation of a Manufacturing Concern," by Mr. H. J. Brocklehurst.

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Aluminium and its Alloys," by Dr. W. Rosenhain, F.R.S. (Lecture II.)

TUESDAY, March 23rd.

Institution of Civil Engineers.

5.30 p.m. At Great George-street, London, S.W. Paper on "The Work done by Railway Troops in France during 1914-1919," by Col. D. Lyell.

Institution of Electrical Engineers.—North-Eastern Centre.

6.30 p.m. At the Technical High School, Darlington. Paper on "Notes on Electric Furnace Practice," by Mr. J. Hedley.

Institution of Electrical Engineers.—North-Western Centre.

7 p.m. At the Engineers' Club, Manchester. Paper on "The Protection of Alternating Current Distribution Systems without the Use of Special Conductors," by Major K. Edgcumbe.

Institution of Electrical Engineers.—North-Midland Centre.

7 p.m. At Royal Victoria Hotel, Sheffield. Paper on "Transformers for Electric Furnaces," by Mr. J. L. Thompson.

Faraday Society.

7.30 p.m. At the Chemical Society Rooms, Burlington House, London, W. General discussion on "Basic Slags: Their Production and Utilisation in Agricultural and other Industries."

Institute of Metals.—Birmingham Local Section.

7.30 p.m. At the Chamber of Commerce Buildings, New-street, Birmingham. Paper on "Some Special Alloys," by Dr. W. Rosenhain, F.R.S.

WEDNESDAY, March 24th.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Industrial Lighting in its Relation to Efficiency," by Mr. L. Gaster.

Industrial League and Council.

5.15 p.m. At the Carpenters' Hall, Throgmorton-avenue, London, E.C. Lecture on "A Defence of Capitalism," by Sir George Paish.

7.30 p.m. At Central Hall, Westminster, London, S.W. Subject: "The Effect of Modern Industrial Methods on Employment and Wages," by Mr. F. C. Lawrence.

THURSDAY, March 25th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Gt. George-street, London, S.W. Discussion on "The Electrical Equipment of Artisan Dwellings," with an Introductory Paper by Mr. L. Milne: and the Report of the Earthing Sub-Committee of the Wiring Rules' Committee of the Institution.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. At the University, Liverpool. Lecture on "Some Experiences in Malaya," by Mr. W. S. Laverock.

7.30 p.m. At the Grammar School, Chesterfield, Lecture on "Some Notes on Iron and Steel," by Mr. A. Chambers.

FRIDAY, March 26th.

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Discussion on "Einstein's Theory of Relativity," introduced by Prof. A. S. Eddington, F.R.S.

Wireless Society of London.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Harmonics in Continuous Wave Transmissions," by Capt. L. A. T. Broadwood.

Wolverhampton and District Engineering Society.

7 p.m. At the Technical School, Garrick-street, Wolverhampton. Lecture on "Coal and Its By-Products," by Mr. J. R. Allett.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "The Future of the Gas Industry," by Mr. W. A. Tookey.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "The Scientific Work of the late the Right Hon. Lord Rayleigh," by Prof. Sir J. J. Thomson, O.M., P.R.S.

On the Localisation of High-Resistance Breaks in Submarine Cables.

By A. POULSEN.
(Assistant Engineer to the Great Northern Telegraph Co.)

Introduction.

In 1876 Dr. Werner Siemens, in a Paper read at the Society of Telegraph Engineers,* proposed a general method by which the distance of a break in a submarine cable could be determined when the resistance in the break was unknown. While we, since then, have obtained methods far more exact when we have to deal with breaks of low resistance, the Siemens method still retains its superiority when dealing with high-resistance breaks.

Briefly stated, this method consists in determining the resistance of the cable up to the break by means of a combined resistance and capacity test, the principle being as follows:

Firstly, the sum of the resistance of the cable and in the break is measured; secondly, the cable is discharged through a galvanometer after having previously been charged from a battery. Part of the charge will then pass to earth through the break, and another part will pass through the galvanometer. If we call R the resistance of the cable up to the break, C the capacity of the cable up to the break, f the resistance in the break, $r=R+f$, q the measured charge, c the apparent capacity corresponding to q, E the E.M.F. of the battery, b the resistance of the battery, g the joint resistance of the galvanometer and the shunt, then we have†

$$q=E\,.\,\frac{C}{R}\,.\,\frac{r^3-f^3}{3\,.\,(g+r)(b+r)},$$

or as

$$q=E\,.\,c$$

$$c=\frac{C}{R}\,.\,\frac{r^3-f^3}{3\,.\,(g+r)(b+r)},$$

from which

$$f=\sqrt[3]{r^3-3\,.\,\frac{R}{C}\,.\,c\,.\,(g+r)(b+r)}$$

$$=r\,.\,\sqrt[3]{1-3\,.\,\frac{R}{C}\,.\,\frac{c}{r}\,.\left(1+\frac{g}{r}\right)\left(1+\frac{b}{r}\right)};$$

and consequently

$$R=r-f=r\,.\left(1-\sqrt[3]{1-3\,.\,\frac{R}{C}\,.\,\frac{c}{r}\,.\left(1+\frac{g}{r}\right)\left(1+\frac{b}{r}\right)}\right).$$

This formula contains, besides the measured quantities r and c, the ratio R/C of the resistance to the capacity of the cable up to the break. This ratio is supposed to be practically constant for the whole cable, and is consequently a known quantity which in the following will be denoted by ρ. The formula then becomes

$$R=r\,.\left(1-\sqrt[3]{1-3\,.\,\rho\,.\,\frac{c}{r}\,.\left(1+\frac{g}{r}\right)\left(1+\frac{b}{r}\right)}\right).\quad .\quad (1)$$

If the resistance of the galvanometer (g) and the resistance of the battery (b) are small compared with r the formula is reduced to the simple expression,

$$R=r\,.\left(1-\sqrt[3]{1-3\,.\,\rho\,.\,\frac{c}{r}}\right).\quad .\quad .\quad .\quad .\quad .\quad .\quad .\quad (2)$$

The Hockin Test.

Mr. Siemens did not go into details as to how the test had to be taken. This was first worked out more elaborately by Mr. C. Hockin,‡ who also originated a method of correcting for the influence of the cable current. In order to be able to take the capacity test immediately after the resistance test, which is of great importance in instances where the resistance in the break is variable, Mr. Hockin in the simplest of the methods he proposes measures the resistance as well as the capacity by galvanometer deflections,* using either one galvanometer for both measurements or separate galvanometers (Fig. 1). Of these two alternatives the latter is, of course, the best, provided the necessary instruments are at hand, as the deflection of the galvanometer G_2 can be read immediately after the deflection on G_1 has been noted, it being not necessary to alter any of the connections nor to wait for any galvanometer coming to rest. By using two galvanometers it also will be possible to choose a dead beat galvanometer for the resistance test and a periodic galvanometer with a sufficient long period for the capacity test, the latter being necessary on account of the retardation of the charge in the cable.

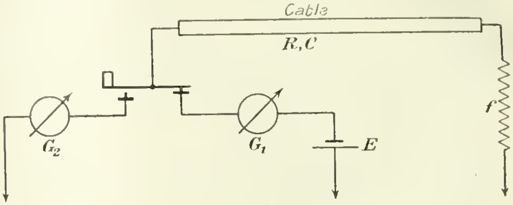

Fig. 1.

Mr. Hockin next compensates for the effect of the cable current by using the following readings:—

d = the permanent deflection when battery current on,
d_1 = the permanent deflection from the cable current,
δ = the throw from the discharge.

The corrected deflection for the battery current will then be

$$D=d-d_1,\quad .\quad .\quad .\quad .\quad .\quad .\quad .\quad .\quad .\quad (3)$$

and the corrected throw from the discharge

$$\Delta=\sqrt{\delta\,.\,(\delta-2d_1)}.\quad .\quad .\quad .\quad .\quad .\quad (4)$$

If the constants of the galvanometer for the resistance test (k_1) and for the capacity test (k_2) have been previously determined, we finally have

$$r=\frac{k_1}{D}\qquad c=\frac{\Delta}{k_2}.$$

The correction for the cable current in connection with the capacity test—which is commonly known as Hockin's correction—is strictly correct only for undamped galvanometers, but may be used also for slightly damped galvanometers, provided $2d_1$ is not too large compared with δ.† A modification of the Hockin formula, proposed by Mr. E. B. Petersen‡ is, however, considerably more correct and is as follows:—

The throw (δ) on the galvanometer having been noted the cable is again charged and discharged *outside* of the galvanometer, and immediately afterwards the galvanometer key is quickly opened, and the throw δ_1 from the cable current is read. Then

$$\Delta=\sqrt{\delta\,.\,(\delta-\delta_1)}.\quad .\quad .\quad .\quad .\quad .\quad .\quad (5)$$

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[*] "Contribution to the Theory of Submerging and Testing Submarine Telegraphs," "Journ." Soc. Tel. Eng., 1876, V., p. 42).

[†] *l.c.*, p. 66.

[‡] "On the Proof of a Formula given by Mr. Kempe," the "Telegraphic Journal," 1876, pp. 220 and 233.

[*] *l.c.*, p. 233.

[†] One also might read the first and the second swing δ and δ', the corrected throw then becoming $\Delta=\sqrt{\delta\,.\,\delta'}$ (*see* Hockin, *l.c.*, p. 231, and H. V. Higgitt, in the Electrician, September 7, 1917, p. 897).

[‡] "The Telegraphic Journal and El. Rev.," 1888, II., p. 618.

This formula holds good even for galvanometers in which the damping is comparatively great, and even for large values of δ_1. For dead beat galvanometers, however, the formula cannot at all be used.

Hockin gives still another correction for the charge due to the cable current, if the resistance of the instrument branch in the charging circuit be not the same as in the discharging circuit (*see* Fig. 1). But as the resistances of the battery and of the shunted galvanometer, as a rule, are small compared with the measured resistance, this correction has seldom any practical value: eventually the two circuits might be made equal by inserting a compensating resistance.

CORRECTION FOR THE RETARDATION.

On account of the retardation of the charge in the cable it is, as already mentioned, necessary to employ a galvanometer with a sufficient long period for the capacity test. Mr. Hockin gives a table* by which this period can be determined for any given length of cable, but in working out this table he takes for granted that the first swing of the galvanometer will be a measure of the amount of the charge which passes during the time the swing lasts. This is not quite correct, as the swing measures the charge correctly only if it passes the galvanometer in a small fraction of the time the swing lasts; besides, an error seems to have been made in the working out of the figures in the table.

When employing slightly damped galvanometers it is, however, possible to arrive at an empirical correction to be used when measuring charges in cables which are *insulated* at the far end, as the correction is dependent on the quantity $\frac{C'.R}{T}$ only.

C' being the measured capacity (uncorrected) in farads,
R being the resistance of the cable in ohms,
T being the time of one complete oscillation of the galvanometer in seconds.

Below is given a table for this correction, found by measuring cables of various lengths with slightly damped galvanometers having different periods.

Table I.—*Correction to be added to C′ in per cent. of C′.*

$\frac{C'.R}{T}$	0	1	2	3	4	5	6	7	8	9
0·0	0	0·1	0·2	0·4	0·6	0·9	1·2	1·6	2·1	2·7
0·1	3·3	4·0	4·7	5·5	6·4	7·3	8·3	9·4	10·4	11·5
0·2	12·7	13·9	15·1	16·4	17·7	19·1	20·5	22·0	23·5	25·0
0·3	26·6	28·3	30·1	31·9	33·7	35·7	37·7	39·8	41·9	44·0
0·4	46·2	48·5	50·8	53·2	55·7	58·2	60·8	63·4	66·0	68·8

From the table it will be seen that if the correction shall be, for instance, less than 1 per cent. we must have $\frac{R.C'}{T} < 0{\cdot}05$ approximately or $T > 20 . R . C'$, which corresponds to a value about 15 times larger than the value given by Hockin.

If the cable be *not insulated* at the far end the discharge will take place in less time and more quickly the less the resistance of the break, but as long as the resistance in the break is not less than the resistance in the cable, and the correction does not exceed 10 per cent., the table still holds good, provided we insert instead of C' the measured apparent capacity c', and for R the resistance up to the break, the latter being calculated from c' and r. If the correction is, for instance, less than 1 per cent. we must consequently have $T > 20 . R . c$.

Below is given an example of a test to a break by the Hockin method.

Example A.—An artificial cable was employed in connection with a break in a gutta-percha core, the electrical conditions of the cable being as follows:—

$$R = 1{,}610\omega \quad C = 84{\cdot}8\mu\text{F} \quad \rho = 19{\cdot}0.$$

For the test a Thomson galvanometer was employed with a period of $T = 4{\cdot}5$ seconds in connection with a universal shunt with a total resistance of 10,000 ohms, and the same galvanometer was employed for the resistance and the capacity test, the connections being altered through a two-pole switch (Fig. 2).

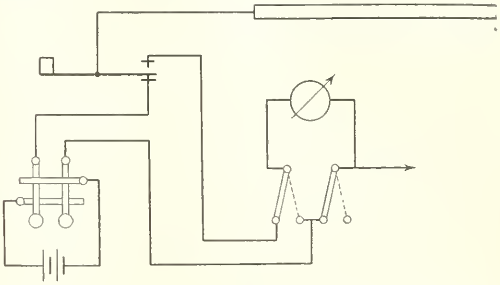

Fig. 2.

The galvanometer constants were found to be

$$k_1 = 2{,}764 \times 10^6 \quad k_2 = 3{,}475.$$

The following measurements were taken with steady copper current:

$$d = +197 \times 4{,}000 \quad d_1 = -7 \times 4{,}000,$$
$$\delta = -202 \times 1{,}000 \quad \delta_1 = -50 \times 1{,}000 \; (d_1 = -28 \times 1{,}000)$$

the values for d and δ being the mean of three sets of readings taken immediately one after another.

Then we have

$$D = d - d_1 = (197 + 7) \times 4{,}000 = 204 \times 4{,}000,$$

and

$$r = \frac{k_1}{D} = \frac{2{,}764 \times 10^6}{204 \times 4{,}000} = 3{,}387\omega,$$

and using the Petersen correction,

$$\Delta = \sqrt{\delta . (\delta - \delta_1)} = \sqrt{202 . (202 - 50)} \times 1{,}000 = 175 \times 1{,}000,$$

$$c' = \frac{\Delta}{k_2} = \frac{175 \times 1{,}000}{3{,}475} = 50{\cdot}35\mu\text{F}.$$

Then we get (formula 1)

$$3\ \rho . c'/r . \left(1 + \frac{g}{r}\right)\left(1 + \frac{b}{r}\right) = 3 \times 19{\cdot}0 \times \frac{50{\cdot}35}{3{,}387} \times \left(1 + \frac{10}{3{,}387}\right) = 0{\cdot}8500,$$

$$R = r \times 0{\cdot}4687 = 3{,}387 \times 0{\cdot}4687 = 1{,}587\omega.$$

As

$$\frac{R . c'}{T} = \frac{1{,}587 \times 50{\cdot}35 \times 10^{-6}}{4{\cdot}5} = 0{\cdot}018,$$

the correction to be used (*see* Table I.) is approximately

$$\frac{0{\cdot}2}{100} . c' = 0{\cdot}1\mu\text{F},$$

and, consequently,

$$c = 50{\cdot}45\mu\text{F}.$$

This does not essentially alter the above result, as a repetition of the calculation now gives $R = 1{,}595\omega$.

It will be noticed that although the galvanometer is rather damped, as will be seen by comparing δ_1 with $2d_1$, the Petersen correction still gives a good result, whereas the Hockin correction would give a too small value for c.

As a check the break was afterwards replaced with a "dry" resistance, and the readings $d = 204 \times 4{,}000$ and $\delta = 175 \times 1{,}000$ were obtained, which are in good accordance with the corrected values above.

The Hockin method is very useful when the break is rather distant, and when the test can be taken from the shore where, as a rule, slightly damped galvanometers are at disposal. But for several reasons the method does not lend itself so well for use when the distance to the break is small or if the test has to be taken from a cable steamer.

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* *l.c.*, p. 234.

Firstly, the cable current in short cables will, if the resistance in the break does not happen to be very high, easily become so strong, and consequently also the throw δ_1 produced by this current so large in proportion to the throw δ from the charge, that the Hockin formula holds good no longer, even if slightly damped galvanometers are used, and for the aperiodic galvanometers used on board ships the correction, as already mentioned, cannot at all be relied on. Secondly, the discharge from short cables takes place so quickly that it is impossible to avoid a part of the charge being lost through the break during the short interval between the removal of the battery and the insertion of the galvanometer.

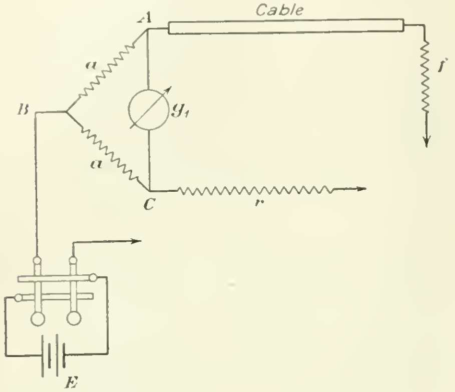

Fig. 3a.

The Schoenau-Gulstad Test for Short Cables.

For use in such cases Mr. W. Schoenau, of the Great Northern Telegraph Company, in 1896, devised a bridge method, which after having been subjected to some modification by the company's engineer-in-chief, Mr. K. Gulstad, has been used by the G.N.T. Company for several years, and has given good results. The test is as follows:—

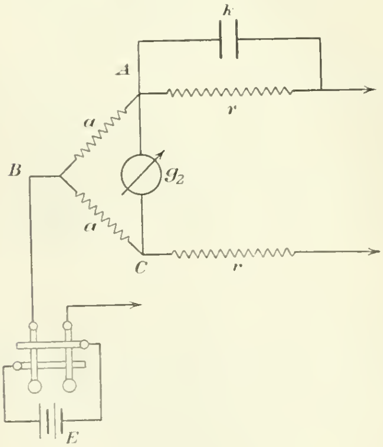

Fig. 3b.

The sum (r) of the resistance of the cable and in the break is measured with a Wheatstone bridge (Fig. 3a). After balance has been obtained, the battery key is released, and the throw on the galvanometer from the discharge is read. Next the cable is removed and a condenser (k), shunted with the resistance (r), is inserted in its place (Fig. 3b), and, after balance again having been obtained, the battery key is released, and the discharge throw from the shunted condenser read.

We have then as before, presuming the ratio being equal,

$$r=R+f,$$

and the part of the charge which passes out of the near end of the cable is

$$Q=E\cdot\frac{r}{a+r}\cdot\frac{C}{R}\cdot\frac{r^3-f^3}{3\,.\,(w_1+r)\,.\,r},$$

where w_1 is the combined resistance of all the branches in the circuit to the left of A (Fig. 3a).

Of this part a certain portion Q' passes through the galvanometer, the portion being determined by

$$Q'=E\cdot\frac{r}{a+r}\cdot\frac{C}{R}\cdot\frac{r^3-f^3}{3\,.\,r^2}\cdot\frac{ar}{(a+r)g_1+2ra},$$

which is independent of the apex of the bridge being insulated or to earth.

In a similar manner the part of the charge in the condenser (k) which passes out to the left of A (Fig. 3b) is

$$q=E\cdot\frac{r}{a+r}\cdot k\cdot\frac{r}{w_2+r},$$

where w_2 is the combined resistance of all the branches in the circuit to the left of A, and the portion (q') passing through the galvanometer is dependent on

$$q'=E\cdot\frac{r}{a+r}\cdot k\cdot\frac{ar}{(a+r)g_2+2ra}:$$

If different shunt values have to be used in the two tests, then g_1 will be different from g_2. In order, however, to simplify calculations a compensating resistance may be introduced that makes $g_1=g_2$. Calling the discharge throw from the cable for U and the discharge throw from the condenser for u, we consequently have

$$\frac{U}{u}=\frac{Q'}{q'}=\left(\frac{C}{R}\cdot\frac{r^3-f^3}{3\,.\,r^2}\right)\cdot\frac{1}{k},$$

or, if we call

$$k\,.\,\frac{U}{u}=c,$$

then $$c=\frac{C}{R}\cdot\frac{r^3-f^3}{3\,.\,r^2}\;;\;R=r\,.\left(1-\sqrt[3]{1-3\,.\,\rho\,.\,\frac{c}{r}}\right)$$

which is the same as formula (2).

The compensating resistance (P) to be inserted in order to make $g_1=g_2$ is easily found if the values of the shunts (n and N) and the resistance (G) of the galvanometer are known. Using an ordinary shunt, the compensating resistance becomes

$$P=G\,.\left(\frac{1}{n}-\frac{1}{N}\right), \qquad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and when using a universal shunt with a total resistance S,

$$P=S\,.\left(\frac{1}{n}-\frac{1}{N}\right)\cdot\left(1-\frac{S}{G+S}\cdot\left(\frac{1}{n}+\frac{1}{N}\right)\right). \qquad . \quad . \quad (7)$$

The cable current is eliminated simply by balancing to false zero (with permanent current), when taking the resistance test, and by using this false zero as the starting point, when taking the discharge throw, the *modus operandi* being as follows:—

1. A copper resistance test is taken with the Wheatstone bridge to false zero, and preferably by using the current which is found to seal up the break (in most cases copper current), the current being permanently on. Call the position on the scale for the false zero for d.

2. The battery key is released and the throw δ from the discharge is read, using d as the starting point. Then

$$U=\delta-d.$$

3. The cable is removed, and a condenser (k) shunted with the resistance measured under 1) is inserted in its place, and, after balance has been obtained, the discharge throw u from the condenser is read. Then

$$c=k\,.\,\frac{U}{u}.$$

In order more fully to illustrate the test and the calculations—which are not so elaborate as they perhaps appear at the first glance—an example of an actual test is given below.

Example B.—An artificial cable was employed in connection with a break in a gutta-percha core, the electrical conditions of the cable being

$$R=399\omega \quad C=22{\cdot}6\mu\text{F} \quad \rho=17{\cdot}65.$$

For the test a Sullivan aperiodic marine galvanometer was employed, having a resistance of 860 ohms, in connection with a universal shunt having a total resistance of 10,000 ohms. When testing the cable a shunt of the value $N=40$ was used and when taking the discharge from the condenser the value of the shunt was $n=4$. The compensating resistance to be inserted when testing the cable being, therefore,

$$P=10{,}000\,.\left(\frac{1}{4}-\frac{1}{40}\right).\left(1-\frac{10{,}000}{10{,}860}\,.\left(\frac{1}{4}+\frac{1}{40}\right)\right)=1{,}680.$$

With permanent copper current kept on the resistance in the break was found gradually to increase; it was, therefore, considered advisable to take several sets of resistance and discharge readings:—

$r=$	4,000	4,000	4,500	4,500	4,600	4,600
$\delta=$	+163	163·5	156·5	157	158·5	158·5 × 40
$d=$	+ 70	70	59	58	60	60 × 40
$U=$	93	93·5	97·5	99	98·5	98·5 × 40

The cable was then removed, and a condenser $k=2{\cdot}03\mu$F (shunted with the corresponding values for r) inserted in its place, and the following discharge readings obtained:—

$r=$	4,000	4,500	4,600
$u=$	95	98	98·5 × 4

Inserting these values in the formulæ we get

$r=$	4,000	4,000	4,500	4,500	4,600	4,600
$c=$	19·9	20·0	20·2	20·5	20·3	20·3
$3\,.\,\rho\,.\,\frac{c}{r}=$	0·2636	0·2650	0·2379	0·2415	0·2340	0·2340
$R=$	388	390	390	396	391	391

The mean value 391 ohms is somewhat too low, which is probably due to the fact that the resistance in the break was found to decrease as soon as the battery was removed. By inserting a "dry" resistance in series with an E.M.F. of 1·5 volts instead of the actual break, the following readings were obtained:—

$r=4{,}000 \quad \delta=133\times 40 \quad d=36{\cdot}5\times 40 \quad U=96{\cdot}5\times 40,$

from which

$$c=20{\cdot}6 \qquad 3\,.\,\rho\,.\,\frac{c}{r}=0{\cdot}2729 \qquad R=403,$$

which is nearer the correct value.

By using this method one has the advantage of being able to use aperiodic galvanometers, so that the method is very applicable on board ships. Furthermore, the interval from the removal of the battery to the earthing of the apex of the bridge will not have any influence on the result as the portion of the charge which passes through the galvanometer has been shown to be independent of the apex being to earth or insulated. This is of great importance when testing short cables. Finally, it is also an advantage that the resistance and capacity tests are taken almost simultaneously.

On the other hand, it must be admitted that it is a drawback that the combined resistance in front of the cable will be very considerable, whereby the charge in the cable is retarded, and the measured capacity becomes too small. It will be seen by referring to Fig. 3a that the combined resistance during the short time the battery is insulated gets greater than r, and, therefore, it is important that this interval does not become too great: as soon, however, as the apex is put to earth the resistance becomes smaller than a. Therefore, it is also of importance that the resistance in the ratio arms of the bridge is not too high: on the other hand, the resistance must not be too small, as this, of course, would tend to diminish the sensitiveness of the galvanometer.

For this reason the method is not so well applicable to long cables, the Hockin method in one form or other being preferable in such cases. When using the Hockin method the resistance of the shunted galvanometer will, as a rule, be so small compared with the resistance of the cable that its retarding influence may be neglected.

Remarks.

In order to facilitate the working out of the Siemens formula a table will be found below, which gives the values of R/r for various values of $3\,.\,\rho\,.\,c/r$. The table is calculated from the formula (2):—

$$\frac{R}{r}=1-\sqrt[3]{1-3\,.\,\rho\,.\,\frac{c}{r}},$$

but, of course, it can also be used in connection with formula (1)

$$\frac{R}{r}=1-\sqrt[3]{1-3\,.\,\rho\,.\,\frac{c}{r}\,.\left(1+\frac{g}{r}\right)\left(1+\frac{b}{r}\right)},$$

if $3\,.\,\rho\,.\,\frac{c}{r}\,.\left(1+\frac{g}{r}\right)\left(1+\frac{b}{r}\right)$ is used as argument instead of $3\,.\,\rho\,.\,\frac{c}{r}$.

Table II.

Values of $\frac{R}{r}=1-\sqrt[3]{1-3\,.\,\rho\,.\,\frac{c}{r}}$

$3.\rho.\frac{c}{r}$	0	1	2	3	4	5	6	7	8	9
0·0	·00000	·00334	·00671	·01010	·01352	·01696	·02042	·02391	·02741	·03094
0·1	·03451	·03810	·04172	·04536	·04903	·05274	·05646	·06022	·06401	·06782
0·2	·07168	·07556	·07949	·08344	·08742	·09145	·09550	·09959	·1037	.1079
0·3	·1121	·1164	·1206	·1250	·1293	·1338	·1382	·1428	·1473	·1519
0·4	·1566	·1613	·1661	·1709	·1758	·1807	·1857	·1907	·1959	·2011
0·5	·2063	·2116	·2170	·2225	·2281	·2337	·2394	·2452	·2511	·2571
0·6	·2632	·2694	·2757	·2821	·2886	·2953	·3020	·3090	·3160	·3232
0·7	·3306	·3381	·3458	·3537	·3618	·3700	·3786	·3873	·3963	·4056
0·8	·4152	·4251	·4354	·4460	·4571	·4687	·4808	·4934	·5068	·5209
0·9	·5358	·5519	·5691	·5879	·6085	·6316	·6580	·6893	·7286	·7846
1·0	1·0000									

When the value of $3\,.\,\rho\,.\,\frac{c}{r}$ is getting small (*i.e.*, when the resistance in the break is very great) the formula (2) may be simplified to—

$$\frac{R}{r}=\rho\,.\,\frac{c}{r}\,.\left(1+\rho\,.\,\frac{c}{r}\right),$$

or

$$C=c\,.\left(1+\rho\,.\,\frac{c}{r}\right),$$

which holds good as long as $\rho\,.\,\frac{c}{r}<0{\cdot}01$.

The error in the final result (R or C) will be greater the smaller the resistance in the break becomes compared with the resistance of the cable. For instance, an observation error of 1 per cent. in c will cause an error of $2\frac{1}{3}$ per cent. in R, when $f=R$, and of $4\frac{1}{3}$ per cent. when $f=\frac{1}{2}R$. Therefore, if the resistance in the break gets smaller than the resistance of the cable, the method becomes inaccurate, but then, as a rule, the resistance in the break may be broken down and other methods resorted to.

Scientific Management: A Solution of the Capital and Labour Problem.

We give below an account of the discussion which took place at a recent meeting of the North-Eastern Centre of the Institution of Electrical Engineers at Newcastle-on-Tyne on Capt. J. M. Scott-Maxwell's Paper on "Scientific Management: A Solution of the Capital and Labour Problem." An abstract of the Paper appeared on p. 716 of our issue of December 19, 1919.

Mr. Arthur Parsons said we had to see whether we could not get more out of our factories, and to do everything possible to increase production. He described a system which had been used for some time by the firm with which he was associated, which was analogous to Capt. Scott-Maxwell's system. When the tendering department sent out a quotation the planning department, who by means of diagrams and other records knew the state of the shops, specified a delivery date to be included in the tender. On receipt of the order, the total time quoted for delivery was apportioned out to the various stages of manufacture, covering all operations from the drawing office to the testing of the completed machine. These times were set out diagrammatically as a continuous horizontal line, the different stages being shown in different colours. Each of the main items comprising the machine had a separate line alloted to it. Directly below this diagram, which was the estimate for the time taken for the manufacture, a similar one was drawn as the work proceeds through the shop, and showed the actual progress made. By this means the position of the work at any moment could be seen at a glance, and after a very few minutes' inspection of such a chart it was easy to see whether the progress made corresponded with what had been promised. In addition to such a diagram, means were necessary whereby details required in the manufacture could be carefully watched. By such a system it was possible to prevent material being ordered and work done before it was due. Motion study had not yet been adopted to any extent in this country, and he was of the opinion that it was better first to study and perfect such a system as he had described. He was of the opinion that payment by results was the only satisfactory method.

Sir Thomas Oliver said that questions of a physiological character had to be faced, and that he favoured a committee which included workmen, employers and physiologists, so that the attention of the latter could be drawn to points in connection with industrial fatigue. Industrial fatigue was partly subjective, that felt by the man himself, and partly objective, that shown in the character of the man's work. The seat of fatigue was not in the muscles, but the centre of the nervous system. Exertion resulted in the formation of lactic acid, the presence of a little of which in the muscles was good, but an excess prevented the expenditure of energy until the lactic acid was removed from the blood by oxygen. Mistakes were made during the war, and people became overworked. Medical men saw the effects in the breakdown of many of the people, who fell a prey to diseases more easily than they otherwise would have done. Men were often more tried than the condition of their muscles indicated. The heart itself suffered slightly in fatigue, and was unable to deliver the normal amount of oxygen to the brain. This, and the poisonous products in the blood, contributed to a sense of fatigue. He thought that the objections to the Taylor system were purely from the trade union point of view. It was contrary to trade unionism. The capacity of men for work and of becoming fatigued varied. The men did not want this investigated. Taylorism had many advantages. It tended to train the muscles to act in co-operation, so that repetition work could be performed without a great expenditure of energy. He was of the opinion that working hours were becoming lower than the physical condition of the body called for. One writer advocated 56 hours as a fair average. Heavy work was not so fatiguing as that accompanied by mental strain, which created a sense of fatigue. He thought that hours should not be uniform, but that each industry should receive special consideration. Each individual had his own particular rhythm, and that there was definite co-ordination between the nervous centres and the muscles. Speeding up raised the heart beats, and should not be carried on too long. By introducing an interest in the work monotony was prevented, and fatigue was not so readily felt. He knew of a cigar and cigarette factory where the girls sang at their work every afternoon, accompanied by a piano, with results satisfactory both to the girls and the employer.

Mr. O. Carter said it must be clearly understood that employers had as much to learn as the workpeople. The system was not merely common sense, but rather the application of hard thinking and experience on a definite plan and for a definite end. He was afraid one of the wrong sort of experts had been the welfare superintendent, and hoped that future experts would not launch upon us the sort of failure that had been the usual experience in welfare work in the past. Simple suggestions by employees might have extremely important results. He had two suggestions to make. The first was that problems and their suggested solutions should be explained rather to individuals than to masses of men, as he thought it more important to produce a strong impression on a few minds than a weaker impression on a large number of minds. He also thought the staff could be used in many ways to elucidate problems, because they were an intermediate body, and had connection with both employers and manual workers. They had, unfortunately, been left out of the scheme of Whitley Councils, but the very fact that they were able to see both sides made them peculiarly fitted to convey to one side the views of the other in an inteligent way.

Mr. G. Raugt questioned whether scientific management achieved all the results claimed. He personally did not agree with some of the figures given in the section on Motion and Time Study, and suggested that these were only based on experiments. Most of them were engaged on production, not experiments. He regarded the third chapter of the section on Fatigue and Rest Factor as a typical example of Government control. He was interested in the question of payment by results, but the difficulties he had encountered were almost too much to put down in writing. The vital point of all success in production was co-ordination and co-operation.

Mr. Bedworth said that it was nearly 20 years since Mr. Taylor introduced his so-called scientific management; but we must not lose sight of the fact that a great change had taken place in the relations between Capital and Labour during that time. Any system to be successful must first receive the support of Labour, and to do this it must be shown that Labour would gain financially, mentally and physically. He did not think that this system fulfilled those conditions. If it were possible to determine beforehand the capacity of both man and machine, how much was going to be given away to labour? How would it benefit the worker mentally? The system robbed a man of his individuality. He was not allowed to think. It was a new idea that retarding thought would increase mentality. How would the worker benefit physically if it were necessary to perform a certain operation in a given time? He said his idea of the right kind of scientific management was simply applied common sense. It was no benefit to know what your assemblers could do if you did not supply them with parts to assemble.

Prof. A. Hallsworth said the best elements of scientific management need only to be put to working men, and they would see the force of the argument. The athletes of the United States beat British athletes as the result of studying their own movements on the cinema. Secondly, scientific management was likely to lead to, and had already led to, valuable results on the question of fatigue. These two positive advantages were the best elements of scientific management, and were so great that in the long run we should be able to carry Labour with us. We must not interfere with the principle of collective bargaining. The real opposition to piece work was not due to objection to the mode of payment. In the Lancashire cotton industry it was quite clearly laid down how the work should be paid for under various conditions, and there was a definite agreement between employer and employee. This was a trade where the piece rate method was definitely welcome. A second point to secure success was that scientific management must not lead to any cutting of piece rates. He could find no justification for cutting at all. It was the worst expedient an employer could adopt, and was one of the great causes of the present restriction of output. In the third place, it was necessary to secure that the new system should not reduce the worker to an automaton. There was a fear that the worker would be allowed less scope for his initiative.

Capt. Scott-Maxwell, in reply, said that it was stated in Birmingham that scientific management was not sufficiently advanced for mass production there. In Newcastle and Glasgow the class of work was different. Mr. Gautt had told him that if the material was ready for the man at the right time this was practically the whole thing. Mr. Taylor thought Mr. Gautt a bit of a traitor to the cause. The medical experts must consult the worker and employer, but the onus of finding a solution must be placed on the medical experts. A special branch of medical science to study physiology and psychology was required. The trade union leaders away from the rank and file were willing to accept scientific management, and said it was a good thing; but they were afraid of the workers, who said they would not have it. He did not believe that work was the best thing in the world. The experts in the United States told him that the employers were far greater stumbling blocks than the men. The experts exposed corruption, and had to go. He also did not like welfare superintendents. The reason why scientific management was taboo in the United States was that it was making such headway that the Socialists got up a political agitation, and a law was passed making time study illegal in any Government workshop. The figures quoted in the Paper were not from a laboratory experiment, but were based on work carried out in workshops amongst the production of other things. He did not want Government control over our daily work. Scientific management applied to the staff just the same as the manual worker. There was a justification for cutting rates. They become established in spite of improved machinery, thus penalising the introduction of improved machinery. It was therefore legitimate to cut rates if capital was spent. He could not admire the so-called initiative of a man who was doing a thing in the wrong way. Scientific management claimed to teach how to do work in the best way, and therefore improved and did not lower character and mentality. Better instruction meant more work. Just as many skilled men would still be required, and they would require to be more highly skilled than at present.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Mr. Touch-Button," or the Home of Beautiful Ideals. By Nancy Berry. (London: Country Life.) Pp. 48. 3s. net.

"American Journalists in Europe." By H. M. Swetland. (London: J. C. Curtiss.) Pp. 115.

"Wireless Telegraphy." By W. H. Marchant. Ind. Ed. (London: Sir Isaac Pitman & Sons.) Pp. ix.+305. 7s. 6d. net.

"Five Figure Logarithms and Trigonometrical Functions. By W. E. Dommett and H. C. Hird. (London: James Selwyn & Company, Ltd.) Pp. 38. 1s. 6d. net.

Direction and Position Finding.*

By Capt. H. J. ROUND.

EARLY WAR TRIALS.

Early in September, 1914, possible uses of direction finding began to be evident, and it was decided to try to improve the Bellini Tosi arrangement so as to increase its accuracy and range. A Bellini-Tosi aerial system was erected on a 70 ft. field station mast at Broomfield. Standard Bellini-Tosi radiogoniometers were connected up to the receiving gear which was arranged for use either with crystals only, or with valve plus crystal. Owing to the short distance over which it was possible to receive signals on a frame when using only a crystal as a detector, none but the very strong stations could be received. When starting work with the valve plus crystal, great divergence was found between the observed and true directions. This was put down to two causes: A coupling between the two aerial systems not due to the search coil; this gave maximum errors in the plane of either aerial. Incorrect tuning and consequent mis-phasing of the two aerial systems; this gave maximum errors in the plane of 45 deg. betwen the two aerials. The first difficulty was overcome by setting out the aerial systems accurately and by more accurate manufacture of the radiogoniometers. The second, by abolishing the double condenser, and using two separate condensers. Tuning and phasing was done by means of a small buzzer transmitting radiogoniometer coupled to the aerial systems. The introduction later of condensers having air as the dielectric gave trouble. This was owing to the type used being a built-up aluminium-vane condenser. It was found practically impossible to avoid resistance in the condenser, as the contact to the aluminium vanes could never be made perfectly good. Brass vanes solidly soldered up were reverted to.

RADIOGONIOMETERS.

During the war practically no alterations were made in the dimensions of the radiogoniometer coils designed by Bellini, except in the number of turns on the windings. Two dimensions of coils which were used for different circumstances are shown (Fig. 1), viz.,

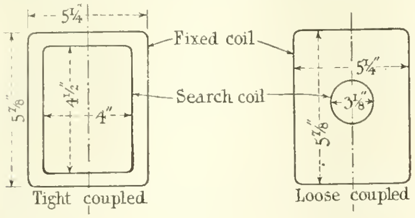

FIG. 1.

(*a*) called "tight coupled," and (*b*) called "loose coupled." Actually both types were tight coupled, for in each case the coupling when at a maximum with one aerial alone was more than that required for maximum signals, if aerial and search coil were tuned to the same wave-length.

To tune to the enemy's wave-length and take his direction rapidly all in the space of a few seconds, it was found that if the aerials were tuned to, say, 800 metres and carefully balanced or phased, then by retuning the intermediate and final circuits, but without altering the aerial tuning, signals could be received with only a slight falling off in strength, from 200 metres below to 200 metres above this tune, that is, from 600 to 1,000 metres. With only the reaction coil and intermediate condenser to handle, operators became very expert at searching over considerable ranges of wave-length. They rapidly found out the German rule for change of wave-length, and the various wireless signals which indicated these changes. With modern amplifiers all these things became easy.

FIRST VALVES AND CIRCUITS.

It was probably fortunate in the first year of the work that soft valves were used, because no hard valve has been constructed which can compare with these "C" type tubes as high-frequency magnifiers. If the "C" valve characteristic is compared with that of a hard tube, the "C" valve is found to be equal in magnifying power either to 16 hard French tubes in parallel, or to three in cascade. With the "C" valve the average high-frequency magnification when using reaction was about 150. Everything suggests that a long ageing is necessary to produce a steady valve, unless success is obtainable with a gas, such as helium or neon.

Quite early in 1915 another error appeared which was nicknamed "vertical." This error was only small, and save for the determination of its cause need not have been regarded. It was noticed that the two zeros of the polar diagram of reception were seldom opposite to one another, even if using only one aerial of the Bellini Tosi system. This was traced to a small "vertical aerial" receptive power, chiefly due to the difference in the capacity of the grid of the valve to earth, and of its battery to earth. It was corrected at first by adding a small condenser from the grid to earth, the value of the capacity being equal to that of the battery to earth. Owing to the smallness of the error, however, this correction was not often applied. With the use of hard valves, and the consequent high insulation of grids, these "vertical" troubles increased a great deal and they increased still more when the "aperiodic" aerial was brought into use. Methods other than the addition of condensers to the grid were afterwards used, for they were more reliable, as they required no adjustment.

NIGHT ERRORS.

Night variation remained throughout the war a serious defect in the direction-finding work, and the following notes are given as the result of researches into the subject.

Large swing readings are better than minimum readings. In England and France, errors on swing readings on spark stations are present up to 7 deg. at night, and seldom more, but there are occasional records of errors greater than this. In the East there are much greater changes than these. The directions change fairly rapidly when bad night effects are present. Two or three degrees in a minute would, however, be considered to be fast. Nearly always, but not invariably, night variations are accompanied by bad minima.

Continuous waves give much greater variations than spark waves, and with them it is quite definite that directions are seriously wrong even when the minima are extremely sharp, although bad minima do occur at other times. Horsea arc station sent its Press programme at 10 o'clock nightly during parts of the war, and it sent with a spacing wave as well as a marking wave. These two waves sometimes gave two directions differing by 30 deg., each wave giving a perfectly sharp minimum. This point may be intimately connected with the results obtained at San Francisco by Dr. Lee de Forest some years ago on interference effects. In studying night effects, continuous waves have the advantage in that no annoying change of note take place, which may cause a doubt as to the exact position of the minimum.

There is no strong evidence to show that the night variations on long waves are greater than those on short. The idea obtained was that this was the case, but this may have been due to the shorter distances worked over on the short waves, and also to the fact that the amount of intervening land was smaller.

In England, variations from east to west are certainly greater than those from north to south, but this result does not agree with results from the East and from America. Malta was a peculiar station, which in England apparently never varied seriously.

When signals come oversea from moderate distances, and practically no land intervenes, results are then the most reliable and can be relied upon for the greater part of the time. If, however, there is land anywhere near either the transmitter or the receiver, or between the two, results become very troublesome. The minimum distance at which night effects have been noticed in England or France is about 15 miles. It was noticed quite early, that when two transmitting stations with differently shaped aerials were side by side, the directions obtained at night by a Bellini-Tosi station were different. Mountainous country between stations seems to give the very worst night effects.

It was noticed that when Zeppelins were well at sea, night errors were not usually serious, but aeroplanes nearly always gave trouble. Experiments were carried out during the day with an aeroplane flying at varying heights, and at different angles to the radius from the receiving station. To see clearly what happens in this case, firstly it must be remembered that the aeroplane, being small and having the aerial flying out backwards, does not usually radiate a wave in which the electrical lines are predominantly vertical and the magnetic lines horizontal. If this vertically polarised radiation only were present, a receiving loop at a distance would receive no signals when its plane was at right angles to the direction of the aeroplane. If, however, the aeroplane is at a height and some of the magnetic field of the wave reaches the loop in such a manner that it is partly vertical in one plane and with the lines leaning forward towards the receiver in the other plane (Fig. 2), a current will be induced in the loop, and the resultant zero position, if the frame is rotated, will be produced by the sum of the two currents due to this effect and that of the vertically polarised wave. It is very noticeable that the error produced becomes negative instead of positive if the aeroplane reverses its direction. A horizontal loop will receive from an aeroplane flying at a height, on account of this twisted field. An aeroplane flying towards or away from a station gives no error. All the above were daylight results, but it was suggested that this aeroplane effect was produced at night by the reflection from irregularities in the Heaviside layer, and there is good evidence that this theory is true. Again, a horizontal loop receives during night variations, and it has been proved experimentally that the strength on the horizontal loop and the night variation agree with the theory in a remarkable way. In the later stages of the war, night errors from Gothas were extremely troublesome, the only satisfactory times being when they were flying either towards or, preferably, away from the observer.

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* Abstract of a Paper read before the Wireless Section of the Institution of Electrical Engineers.

With so many possible errors at night, it was never safe to use only two groups, in fact, one gained a false confidence in the beautiful intersections made by using only two stations and only had occasional shocks when the German fleet was found to be well inland. A third station enabled one to know much more definitely if results were of value, and four was preferable, the last one being a check on the other three.

A system of good rapid land-line communication to a centre was very essential, and our Post Office in England and the Army authorities in France did magnificent work in this direction. Besides these groups of stations, many single stations were erected, particularly for submarine work, and very valuable results were obtained.

Short-wave Work on Rotating Frames.

The Bellini-Tosi system is undoubtedly the most rapid and accurate method of taking directions, but many troubles were experienced when we began to need short-wave direction finders. This was in days before the cascade amplifier came into its own. For short-wave reception under 300 metres it was necessary to use rather large rotating frames, and only just as the war was finishing could waves under 200 metres be tackled satisfactorily on the Bellini-Tosi system. The mass of a frame will always be against the use of the latter for good work because, although ultimately there is no real difference between a rotating frame and a Bellini-Tosi in accuracy in clear places, the ability to take an extremely rapid reading makes the Bellini-Tosi infinitely preferable.

With a frame, the balancing troubles do not occur, but the "vertical" error is just as bad and requires just as careful attention. In consequence of the balancing trouble on short waves, a large number of frames were erected for direction-finding German aeroplanes which were working on short waves, and the work done by these stations in conjunction with the Flying Corps must have had no inconsiderable influence on the flying side of our campaign. As many as 11 German spotting-planes were brought down in one week due to the intelligence work of these stations. One advantage that the rotating frame had to some extent over the Bellini-Tosi was the rapidity with which it could be erected in times of any movement. This would no longer hold with the modern "aperiodic" direction finder.

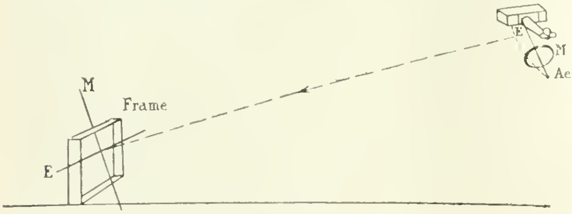

Fig. 2.

Further Improvements.

One of our difficulties was rapid searching over long ranges of wave-length. The first real solution was indicated in 1915, when it was suggested that the aerial tuning condensers should be short-circuited and a closer coupling made between the search coil and the aerial inductances. A first trial of this method resulted in serious errors and weak signals. But a simple solution was obtained which was suitable for all waves above 1,000 metres, by earthing the mid-points of the two direction-finder coils. The minima in the daytime were now very sharp and the directions accurate. With only slight modifications of apparatus this remained the standard continuous-wave apparatus during the remainder of the war. This was also the basis of the "aperiodic" spark direction-finder when the cascade amplifiers were produced (Fig. 3).

Fair sensitiveness with hard tubes was obtained by the process of stepping-up potentials on the grids to the maximum possible, and by paralleling several tubes. In June, 1916, five high-frequency magnifications on 200 metres were obtained by tuned circuits with much harder stable tubes, and extraordinary magnification was obtained. One form of circuit, suggested by Russell Clarke's multiple tuning circuits, consisted of a number of circuits loosely coupled together with all the tuning variometers moving together. The initial trouble in tuning, and the final narrow range of wave-length owing to reaction oscillating troubles, made the gear only possible for very special work.

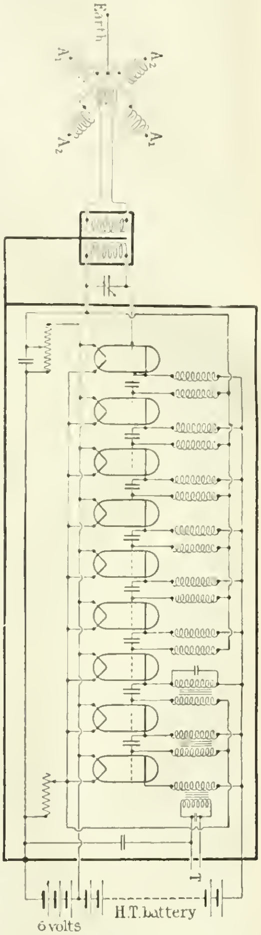

Fig. 3.

In an attempt to get rid of the reaction trouble it was gradually recognised that the real solution of the problem would be in trying not to get too much magnification per valve, and resistances were inserted in all the circuits to damp the oscillations out. The French modification of the audion was by that time in general use, and the French had already constructed resistance cascade amplifiers for long waves.

Any attempt to construct resistance amplifiers failed, and the reason soon became obvious. For waves under 1,000 metres the capacity of the valves themselves and of the connections to them formed an impedance which was lower than the lowest resistance that gave cascade magnification.

A careful study of a Latour transformer indicated that the previous cascade amplifier, with resistance to stop reaction, was the right thing, but it had not been taken far enough.

A three-valve cascade amplifier, built with fine wire coils of one layer, gave a result as good as the Latour amplifier, but the addition of more valves at once caused serious oscillations, and a grid potentiometer became necessary to prevent oscillations, *i.e.*, to give grid damping to the circuits. Valves were then constructed with more open grids and with all capacities cut down to a minimum. Still the aperiodicity was not sufficient, and the magnification required was present over a range of only 200 metres. The copper inter-valve windings were now replaced by resistance wire wound to exactly the same dimensions, which wire for all ordinary work consisted of No. 48 "Eureka." The damping applied by the resistance was of the same order as that applied by the valves themselves, and any variations in valve constants were balanced.

The coils required were now so short and the valve capacities comparatively so much more, that the damping provided by the No. 48 "Eureka" wire was insufficient to give, without the sets oscillating, the required magnification and range of wave-length. Messrs. Edison & Swan offered to draw nickel-chrome wire down to 1 mil in thickness. The resistance of this wire for the same length is about 3½ times that of No. 48 "Eureka." This was very satisfactory and a very good degree of flatness was obtained with the seven valves over the range of wave-length required. The magnification is not so good as in the longer wave sets.

Still shorter wave sets have been produced with this wire. Of course, the shorter the wave-length the narrower the range which can be obtained, but cascade sets with a range of from 30 to 50 metres can easily be produced if such wave-lengths are ever required.

Using this wire with coils wound of the same length as the first amplifier mentioned, a set of 11 valves was made of approximately equal sensitiveness from 250 to 10,000 metres; the higher values being obtained by using the resistance potential drop across the coils, and the shorter wave magnification, as before, being due to the neutralisation of the capacity effects by the inductance. Both the initial and maintenance expense of such a set rather prohibits its use at present, and actually such a range of wave-lengths is seldom required.

Many sets were made up for special work, a standard set of 11 valves being used for short waves in which the damping of the valve circuit was less than the extreme values used above, because only narrow ranges of wave-length were required. This set had a voltage amplification at 200 metres of 2,000, and when more magnification was required, two sets could be loosely coupled together without running into oscillation troubles.

"APERIODIC" AERIAL SPARK SETS.

"Aperiodic" amplification was now all that could be desired, a rather heavy consumption of valves and valve current being the only disadvantages. At one group of naval stations a pair of 7 H.P. charging engines were found necessary, and 130 valves were running continuously. Almost at once, quick-search one-condenser aperiodic direction finders came into use for spark waves. With the introduction of the "aperiodic" direction finder, it was found that direct reception on any of the coils in the receiver was introducing slight errors. In the case of the search coil of the radiogoniometer, this can be avoided by placing the radiogoniometer in a correct position on the table. In the case of all other coils, it is avoided by metal shielding. The metal shield inserted between the windings of the transformer is an effective method of avoiding "vertical" except on waves under 400 metres, when in addition it is necessary to earth the centre of the aerial. The diagram (Fig. 3) shows nine valves, six of these are for high-frequency magnification, the seventh for rectification, and the last two for low-frequency magnification.

If direct reception is required on a frame, and this, as far as sensitiveness goes is the most efficient method, then with all modern amplifiers with a non-conducting grid circuit the frame should have the maximum number of turns and the smallest condenser which the receiver will take. This limit is usually defined by the amplifier oscillating beyond control.

DIRECTION FINDING ON SHIPS AND AEROPLANES.

Quite early in the war several ships of H.M. Navy were fitted with direction-finding apparatus, but no good chance to investigate errors on board ship occurred till 1918. Commander Dorling of H.M.S. "Warspite" succeeded in obtaining a very large number of readings on the "Warspite," but the crowding of all the readings towards the 0 deg. and 180 deg. directions, *i.e.*, fore and aft, was very troublesome for taking readings, and it was decided to attempt a modification of the Bellini-Tosi system to correct these errors, which amounted in other cases to as much as 30 deg.

Only since the Armistice has there been an opportunity of trying out direction-finders on aeroplanes. The four-engine Handley-Page which went to Newfoundland, was fitted with an extemporised Bellini-Tosi, using an aerial system exactly as on board ship. One aerial was lengthwise round the wings, and the other lengthwise round the fuselage. An eight-valve long-wave amplifier set gave very satisfactory signals. Magneto noises which were extremely bad owing to the large number of magnetos, were overcome by shielding the magneto leads, and, what was more important still, by shielding the complete receiver system with the exception of the aerials. This set was used effectively in the flight from St. John's to the United States, during which flight directions were taken on Clifden.

All the later work on ships was done with Wright's inductive loop aerial or "aperiodic" aerial, and Wright has during the last year developed an extremely small and practical ship direction-finder for use with this type of corrected frame. One advantage a warship has over most merchantmen is that there is fitted a gyro compass with repeater compasses, one of which can be near the direction-finder. If no gyro compass is fitted, the exact direction of the ship is extremely difficult to get simultaneously with the reading taken on the radiogoniometer, especially if the ship is turning or yawing. A useful addition to a ship's direction-finder would be a magnetic compass repeater.

Positive Rays.

On Saturday, February 21st, Sir J. J. THOMSON, O.M., P.R.S., opened a series of six lectures on "Positive Rays" at the Royal Institution. We briefly abstract the first three of these lectures so far delivered.

In his introductory remarks Sir Joseph stated that he would not confine himself to positive rays, but would deal with electric methods of studying the properties and constitution of matter. The advantage of these methods was that we could easily test electric charges and could put enormous energy into the atoms. The energy carried by a gas molecule at ordinary temperature was of the order of the work done in pulling it by an electric force of $\frac{1}{3}$ volt. To get the equivalent of 1 volt we should have to raise the temperature to 30 · 273 C. Showing then Goldstein's original "Kanalstrahlen" experiment of 1886, he said that with cathodes of various shapes, "sandwich" cathodes (two foils pinned together so as to leave air space between them), tubes cut off at various angles, wires, &c., peculiar patterns of rays could be obtained. When a zinc cathode was perforated, Aston had found that the main luminescence was in front of the holes, not in front of the whole metal. That was because in front of the metal the electrons were hurled off at high speed, and were not caught by the positive particles, which was necessary to maintain the current, whilst in the holes the electrons moved more slowly and could not escape the positive particles. Striking the glass walls or a willemite screen, the positive rays called forth the fluorescence, which like other fluorescences [compare Perrin, "Annales de Physique," V., pp. 133-158, 1918], was subject to fatigue.

For measuring purposes the rays were projected through a very fine tube—the finest obtainable copper tubes, drawn out subsequently to 0·1 mm. diameter—so as to strike the photographic plate normally or (in the Aston method, later described) obliquely. The plates were Schumann plates or Paget process plates; the latter, of very fine grain, gave sharper traces, but were not so sensitive as the former. To separate the particles of the several components, of different masses moving at different speeds, they were deflected first by a magnetic field and then by an electric field at right angles to each other. The heavier and swifter particles were less deflected than the lighter and slower. The magnetic deflection y was proportional to e/mv, and would produce a continuous vertical band with the heavy swift particles near the spot where the undeflected rays would strike. The electric deflection χ was proportional to e/mv^2, and hence $y^2 = C\chi e/m$, which was the equation of a parabola, C being a constant. Thus, the atoms or molecules of each constituent would produce a parabolic trace on the plate, the hydrogen parabola being always most deflected, and the mercury line (never absent) near the abscissa. The disadvantage of this method was that the heavy particles and their curves were crowded near the abscissa; if the plate were placed nearly horizontal, the rays would strike obliquely, and the traces would be further apart, but less well-defined. The parabolas on the normal plates did not commence at the origin, however, but nearly all on the same ordinate, some distance from the y axis. Sometimes, however, more or less straight traces, faint as a rule, joined this commencement of a parabola to the origin. These secondary traces were explained as follows: A positive particle need not remain positively charged all the time of its travel; it might temporarily be neutralised or even assume a negative charge. The deflection for the same mass and speed would then vary, and a particle, instead of hitting one corner of a square (diagrammatically) might go to the three other corners. That was tested by arranging two magnetic fields, the one behind the other; a particle having lost its charge would not further be deflected by the second field, whilst a charged particle would move on in another direction. The electric fields also had to be considered, and if they were very short, but very intense, the secondary traces were not seen, while if the magnetic field were very long, the deflection might be merely in the vertical. These effects were only noticed when the gas pressure in the bulb was not very low. Since, now, the displacement depended upon e/mv^2—*i.e.*, the energy—all the parabolas started on the same ordinate.

The principle of the focus method of Aston was the following: A particle of a horizontal ray was electrically deflected by an angle, α_1, a slower particle by a greater angle, α_2; both rays were then deflected magnetically, the second again more, so that the two rays were brought to a focus at A. A line passing through A roughly parallel to the original rays would be the locus of all the foci, and if a photographic plate (or narrow strip) were placed along that line, the parabolæ of the other method would appear in the shape of hyperbolic bands crossing that strip. Instead of the tube for the projection of the rays in the bulb, a slit could be used. By this focus method Aston had shown that neon of atomic weight 20·2 really was a mixture of two gases, at wt.20 and 22. Five bands were generally distinct on these strips, carbon C 12, CH 13, CH_2 14, CH_3 15, CH_4 16, the first band being the brightest; they were all due to traces of hydrocarbons (which were purposely added sometimes) and equally spaced, and would thus serve as a scale. The photographic strips further showed bands at 20/2 = 10 and 22/2 = 11, which was a confirmation of the fact that neon had two constituents. Another method went back to the parabolic traces. When the photographic screen was replaced by a metal screen, and a hole was cut in the shape of the expected parabola, the rays would pass through that hole and could be collected in an apparatus in which their charge was measured. It was not necessary exactly to hit the hole, because the rays could be driven up to it by magnetic force if necessary. That method was less convenient and less suitable for measurements, but it indicated the quantity of the respective gas present, which the other methods did not. Thus, with a mixture of (1H + 2O) or of (2H + 1O) we obtained peaks of *H* and *O* atoms and molecules, the heights of the peaks corresponding to the proportions of the gases, in addition to low peaks due to impurities. This method could also be applied with low potentials, whilst the others required thousands of volts, and always showed the hydrogen parabola strongly though very little H might be present. Owing to the low potential, the method should also be suitable for investigating the intermediate products of chemical reactions which high potentials would decompose. In order to drive the particles through the narrow tube of the discharge bulb, a gauze screen, charged from a battery, was placed in front of the tube inlet and connected with the cathode, or the particles were speeded up outside the tube with the aid of charged gauze screens. As regards the alkali metals, another method again was available, the so-called anode-ray method. When the anode was made tubular and filled with a mixture of alkali salts and black-lead, &c., and was surrounded by a coiled cathode, "anode rays" were emitted; they were identical with positive rays, but they did not pass through any cathode perforations. All these methods answered only for gases and readily-volatile substances. We might, however, make use of small Coolidge bulbs of quartz, which could be heated in a furnace, while the anti-cathode (of the respective substance) would be heated by the stream of electrons. Sir Joseph then explained some of his photographs. Oxygen, *e.g.*, showed the molecule, the atom, and the atom curve with two charges, or with a beak, indicating that the atom had lost one of these two charges. It was interesting that the inert gases also carried multiple charges — argon four, krypton up to five; in the case of mercury eight charges were possible, but he had obtained evidence of seven charges only so far.

A Method of Measuring the Magnetic Hardness of Ferrous Metals and Its Utility for Carrying Out Research Work on Thermal Treatment.*

By L. A. WILD.

If an iron ring is wound with several turns of insulated wire and a direct current is sent through this winding the iron becomes magnetised. On the current being withdrawn a certain amount of magnetism remains, which is called the remanent flux. The remanent flux can be entirely removed by sending round the winding a reversed current of suitable value. Where *C* stands for current in amperes; *T* stands for the number of turns; *L* is the length of magnetic circuit in centimetres; *Hm* is the magnetising force in gausses: $Hm = 4\pi TC/L$. Similarly when a reversed current is applied, the demagnetising force *Hd* also equals $0{\cdot}4\pi TC/L$. When the demagnetising force is only just sufficient to wipe out the remanent flux it is called the coercive force and may be written *Hc*. In any specimen the value of *Hc* is dependent upon the value of *Hm* if the magnetising force is small, say under 50 gausses. But when the magnetising force is nearly sufficient fully to saturate the iron the value of *Hc* becomes a constant for each particular specimen. The magnetic hardness may then be defined as the coercive force after having been magnetised to saturation.

The orthodox manner of obtaining *Hc* is to wind a ring of the material under test with both primary and secondary windings. By a process of trial and error a demagnetising current is found which on being switched on and maintained gives a throw on a galvanometer connected to the secondary winding of just half the value obtained on reversing the remanence. From the reading on an ammeter in the primary circuit this current is obtained, and coercive force required entirely to demagnetise the specimen is thus calculated. A ring is an inconvenient form of specimen to prepare and the winding of it is tedious. A saving in time can be effected by making up the magnetic circuit of two rods of circular section, united by a couple of short yokes of annealed wrought iron, but it is a detriment that specimens have to be prepared in pairs and the testing is also tedious.

In order to overcome these difficulties the author develops the following method. The specimen consists of a rod of half an inch diameter and 3 in. in length. This can be cut from an half-inch bar and the ends finished with a file; or the specimen may be turned from a larger bar, as very often in commercial bars the surface is partially decarbonised. In Fig. 1, *S* represents the specimen. This is laid inside the magnetising coil *C* and then the yoke *Y* is placed in position. Current is flashed on to the coil for less than a second. The coil is wound with 500 turns of No. 18 copper wire. The current is taken from a 20-volt battery giving a current of about 20 amperes, or a magnetising force of about 1,600 gausses, which is more than sufficient to saturate any specimen. During this short time the coil has no time to heat up appreciably. The specimen is left magnetised. The yoke is then lifted and the demagnetising effect of the poles removes most of the magnetism remaining. A small modicum remains, and this is proportional to the coercive force of the specimen.

The specimen is then withdrawn from the magnetising coil and is stood upright inside a coil connected to a ballistic galvanometer or flux-meter; the latter has the advantage that it is sent out ready calibrated. On withdrawing the specimen quickly from the coil a throw is obtained on the galvanometer which depends on the flux remaining in the specimen. If necessary, by using a suitable winding for the coil, the galvanometer may be made to read directly in terms of coercive force. The ballistic coil should not exceed ½-in. in length and 1 in. in diameter; otherwise it will not take in all the lines of force. The coil must be midway between the ends of the specimen.

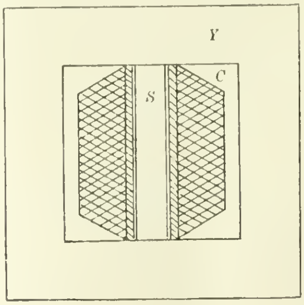

FIG. 1.

After taking the first throw the specimen should be reversed in the ballistic coil and a second throw taken. The average of the two readings thus obtained is taken as the true measurement. Such specimens are not difficult to produce and the procedure is simple. After the specimen has been prepared a test can be made in less than 2 minutes and the result repeated if necessary.

Now as to the theory of the method. In Fig. 2 the line *HRC* represents the demagnetising curve of a specimen of tungsten magnet steel. *OI* is the remanent flux on closed circuit. *OC* is the coercive force or the demagnetising force required to entirely demagnetise the specimen. The line *OR* is called the demagnetising coefficient. Its slope depends upon the dimension ratio (length/diameter) of the specimen, in this case 6. The corresponding demagnetising coefficient is 0·415, *i.e.*, $OD = 0{\cdot}415\ RD$. The demagnetising coefficient for all values of dimension ratio were determined by Prof. Silvanus Thompson ("The Magnetism of Permanent Magnets," "Journal" of the Institution of Electrical Engineers, No. 217, Vol. 50, February 1913).

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* Abstract of a Paper read before the Faraday Society.

DR is the quantity actually measured. Evidently this must be nearly, if not quite, proportional to OC, provided that the specimen is sufficiently short to give a high demagnetising coefficient.

Prof. Thompson having determined the ratio of RD/OD, it remained for the author to determine by experiment the ratio of OC/OD. A pair of long bars were tested in the orthodox manner and were accordingly cut up and tested by the new method. The ratio OC/OD was thus found to be 1·05.

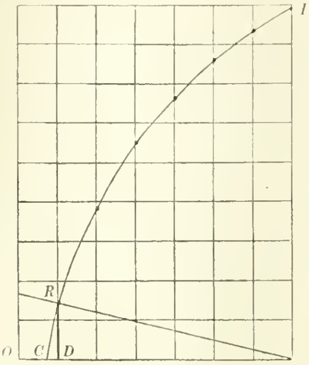


Fig. 2.

With a galvanometer sealed in units of 10,000 Maxwell-turns and reading to 100 units, which is the normal calibration of the Grasset Fluxmeter, the instrument becomes direct reading in terms of coercive force when a ballistic coil is used wound with 275 turns of wire.

Where B = flux density in centre of specimen.
I = intensity of magnetisation.
A = area of specimen in square centimetres
T = turns on ballistic coil.
Hd = demagnetising force.
Hc = coercive force.
D = demagnetising coefficient.

Then $B = 4\pi I$.
$A = 1{\cdot}263$ sq. cm.
$Hd = DI = 0{\cdot}415\ I$.
$Hc = Hd \times 1{\cdot}05$.

And Throw $= BAT/10{,}000$.
$= 4\pi IAT/10{,}000$.

Throw $= 4\pi HdAT/10{,}000 \times D$.
$= 4\pi HcAT/10{,}000\ D \times 1{\cdot}05$.
$= 4\pi Hc \times 1{\cdot}263 \times 275/10{,}000 \times 0{\cdot}415 \times 1{\cdot}05$.
$= Hc \times 1$.

A galvanometer or fluxmeter with a range up to 100 gausses of coercive force is quite convenient for testing all steels containing sufficient carbon to harden, but for wrought iron or mild steel the indications are too low on the scale and an instrument of about 10 times the sensitiveness is required. The specimens need not be accurately dimensioned. An error of 4 per cent. in the diameter, making 8 per cent. in the area alters the demagnetising coefficient by 7 per cent., so that the effect upon the readings obtained is only a difference of 1 per cent. Nor need the specimens be a particularly good fit in the yoke as there is plenty of magnetising force allowed in excess of requirements to bridge any small air gap. This method of testing has permitted the author to carry out quite a large number of heat-treatment experiments, which otherwise would never have been done.

Treatment Experiments.

In heat-treatment experiments an electrically-heated salt bath furnace appears essential. The tempering bath used has also been electrically heated. All high temperature measurements have been made by pyrometer. This can conveniently be checked by taking with it the magnetic change point of a bundle of iron wire, using the Wild-Barfield pyroscopic detector to indicate the moment when the iron reaches the $A2$ point. The pyroscopic detector has also proved of considerable utility in determining the minimum hardening temperatures of steel.

Iron and Mild Steel.

The first set of experiments carried out by the method were on iron and mild steel. The results of these tests are presented in the Table.

Table.

Treatment.	Iron.	Coercive force. mild steel.
Normalised	0·95	1·80
Annealed	0·90	1·77
Annealed and matured (215 C.)	1·52	2·03
Annealed and tempered (215 C.)	1·60	2·42
Refined	1·39	5·00
Refined and matured (720)	1·22	3·30
Refined and matured (750)	1·11	1·77

Normalising means heating to just over the magnetic change point and then withdrawing from the furnace and cooling in air; annealing is meant that the material is heated to just over the magnetic change point, then cooled in the furnace till some 50 deg. below the change point, and then finished in air. Subsequent heating up to any temperature below the magnetic change point and cooling in air is called maturing. The same treatment, but finishing in water instead of air, is called tempering. Heating up to the $AC\ 3$ point and quenching in water is called refining.

Iron attains its softest condition when annealed. Maturing or tempering at a temperature of 215 hardens iron considerably. Refining has a lesser hardening effect than maturing at 215. After the iron has been hardened by refining it cannot be brought back to its annealed softness without heating above the magnetic change point to recrystallise the ferrite. Mild steel is also hardened somewhat by maturing or tempering, but is still further hardened by refining. Mild steel can be brought back to its annealed softness by maturing just below the magnetic change point. The hardening effect of maturing after annealing has not been found in high carbon steels.

Hardening Steels.

Experiments have been carried out on seven steels. The results are presented in the graphical form (Fig. 3), which shows the effect of heating temperature upon three steels, quenched in water at a temperature of 20 C. In all cases the hardness is reduced by overheating, but the higher the carbon content the greater the fall.

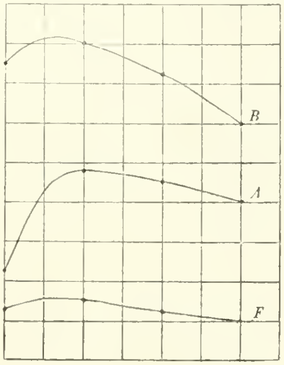


Fig. 3.

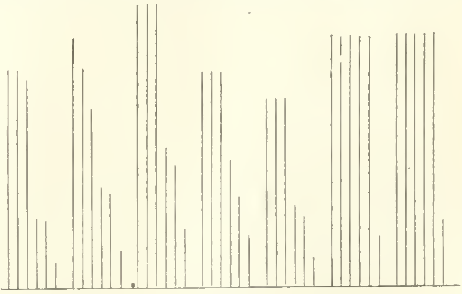


Fig. 4.

Fig. 4 shows the effect of various quenching mediums on all seven steels. Taking steel A, for example, a steel containing 0·7 per cent. carbon and 0·33 per cent. manganese, it will be seen that the full hardness is given by water quenching. Brine also gives full hardness, but a solution of zinc chloride gives a slightly reduced hardness. From this to sperm oil is a big drop. Temperite gives nearly as much as the best oil, and annealing gives the softest condition. Steel *B*, which contains 1·25 per cent. carbon, is much more sensitive to the nature of the cooling medium. There is a decided drop in brine. In zinc chloride the steel is not ever so hard as steel *A*, but in oil it recovers somewhat and is harder than *A*. The annealed hardness is also greater than with *A*. *C*, tungsten and magnet steel, is the hardest steel of all. The tungsten has also the effect of reducing the sensitiveness to delayed quenching. *D* is of interest, as similar steels containing about 1 per cent. of manganese are commonly sold as oil hardening steel. However, when quenched in oil it is little more than half hard. *F* is a true oil-hardening steel, brought about not so much by the addition of manganese as by merely 0·5 per cent. of chromium. *G* contains 10·6 per cent. of chromium. In the annealed state it is the hardest steel of all. It was found, however, to be quite easy to turn in the lathe.

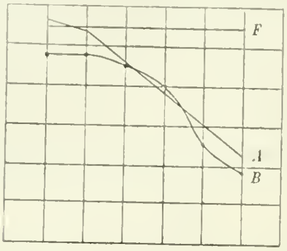


Fig. 5.

In Fig. 5 will be found a comparison between three steels when quenched in water at various temperatures ranging from 10 C. to 60 C. Steel *A*, a high carbon steel, drops a little when the temperature of the water is increased from 10 C. to 20 C., afterwards it drops much more rapidly, and strangely enough in an almost perfectly straight line. The very rapid quenching required by this steel explains why it is that so often with high carbon steels soft spots are found after quenching. Steel *B* shows no fall in hardness till 20 deg. is exceeded, then the drop begins with a gradually increasing rapidity till 50 deg. is reached. At 40 deg. the lower carbon steel is harder than that with the larger carbon content. Steel *F*, which is a true oil hardening steel, maintains its full hardness right up to 60 deg.

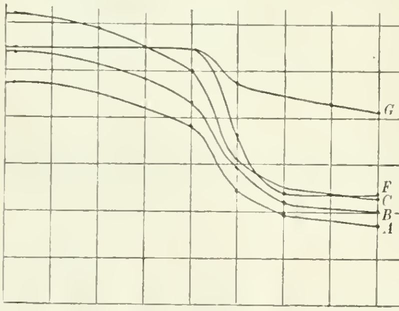


Fig. 6.

Fig. 6 shows the effect of tempering. Steels *A*, *B* and *C* behave all in much the same way. Tempering is shown at as low a temperature as 100 deg., the big drop, however, comes between 200 deg. and 250 deg. The total drop at 400 deg. is the same or very nearly so for all three steels. When there is chromium in the steel, a pleasing variety is met with. Steel *F* shows no tempering action whatever below 200 deg., the drop between 200 deg. and 250 deg. is very sharp, and then beyond 300 deg. there is no change whatever. It only takes 0·5 per cent. of chromium to make all this difference. Steel *G*, containing 10·6 per cent. of chromium, is interesting on account of the very small drop compared with the other steel.

A question that will naturally be asked is,—how does magnetic hardness compare with other forms of hardness? There are so many possible definitions of hardness. A fitter would define it as meaning offering high resistance to a file. A machinist would say difficult to turn in the lathe. A maker of ball bearings might ask for high resistance to wear. Then there is resistance to crushing. A general comparison can be made with the readings of the Brinell machine and the scleroscope, which give very similar results. The magnetic method has the great advantage of having a very much more open scale over its whole length. Whereas the readings of a scleroscope may vary from 25 to 100 or four times, the range on the magnetic scale is about 70 times. In comparing steels of different composition, the magnetic method classes material in the same order as the scleroscope as far as ordinary carbon steels are concerned, having only a comparatively low manganese content. The addition of magnanese reduces the scleroscope hardness of water quenched steel and leaves the magnetic hardness unaltered. Magnanese increases the magnetic hardness of annealed steel without producing a corresponding increase on the scleroscope. Tungsten increases the magnetic hardness of water quenched steel, but it reduces the scleroscope hardness.

Under these circumstances the author cannot claim to have produced a method of measuring any and every sort of hardness. The method, however, is of great utility for the investigation of heat-treatment problems, and should find a place in a works laboratory, where it may be used for such purposes as deciding between the merits of different oils for quenching, the degree of care required for tempering and kindred problems, as they arise.

International Motor Boat and Marine and Stationary Engine Exhibition.

The International Motor Boat and Marine and Stationary Engine Exhibition was opened at Olympia, London, on Friday last, and remains open until to-morrow. In spite of its comprehensive title, there is little at the Exhibition to interest the electrical engineer pure and simple; but as most electrical engineers are neither pure or simple—that is, they like to keep themselves in touch with what is going on in allied branches of engineering—those whose thoughts turn particularly towards shipping and internal combustion engines will by this time have, no doubt, spent an instructive hour or so among the stands.

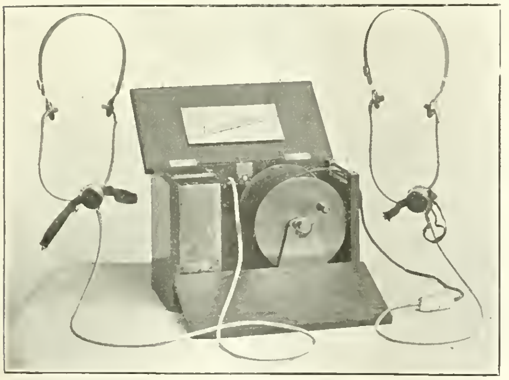
In the space at our disposal it is impossible to deal with the exhibits in any detail, and we must confine ourselves to tendencies. In both the boat and engine sections the principal tendency seems to be toward standardisation, the production of a smaller number of types in larger quantities. Engine designers seem to be turning more and more towards the problem of using fuels other than petrol. As at the recent Automobile Exhibition, so at this one, an increasing number of engines are being fitted with electric starting. On the boats and yachts electric lighting is common, and we have no doubt electric heating and cooking will soon be introduced.

Messrs. Vickers Limited (Stand No. 15), in addition to showing a number of their standard marine type Wolseley engines for both petrol and paraffin working, also exhibited a 10 h.p. crude oil Vickers-Pelter engine, which can start rapidly from cold without heating, and is designed for easy reversing. One of the Wolseley engines was fitted with a Vickers' electrically-operating reversing gear. This is of the enclosed bevel type, and is controlled by magnetic clutches, which in their turn are controlled by switches automatically operated by the engine throttle lever. Thus, the engine can be absolutely controlled by the use of a single lever.

The only exhibit of heavy electrical apparatus was that on the stand of the Igranic Electric Company (Stand No. 13). This included examples of a battery charging equipment which is designed for use, not only with motor boats, but with electric vehicles. It is standardised in sections, like the Globe Wernicke bookcase, and can easily be made up to any size. The standard section includes a reverse current relay, a 15-step rheostat, a meter reading switch, grid type resistance, indicating lamp overload and instrument fuses. Another interesting exhibit was the automatic engine starting switch; this allows the dynamo to be run as a motor from a secondary battery. When the engine is up to speed, the starter is automatically cut out of circuit. This is combined with a control switch for stopping the engine. Electric heating uniits for boat houses and switches for controlling the navigation and internal lights of motor boats were also shown, and electric heating was represented by a soldering iron with an automatic economy rack, a device for saving the iron from breakdown by putting a resistance in series with it when it is resting on the holder.

The British Thomson-Houston Company, Ltd. (Stand No. 11) had a representative exhibit of their motor car and aeroplane magnetos. The capabilities of this apparatus were demonstrated by mounting the different types on pedestals and driving them by electric motors, so that the sparking characteristics at all speeds could be observed. The magnetos shown included the A.V. 8 and 12 types polar inductor magnetos for aeroplane service, which were described at some length in The Electrician for March 21, 1919, and the "A.Q." polar inductor pattern, which was specially designed in 1918 to meet the requirements of the Air Force for a light weight nine cylinder apparatus. In this magneto of the "A.V." type the armature winding is stationary, but the inductors are arranged with the axis of the magneto laying in a plane at right angles to that of the spindle, as in the conventional Bosch design. The inductors are entirely laminated, as are the magneto pole-pieces, which are cast into an aluminium housing. The complete magnetic part interposed between the two poles of the magneto is, therefore, laminated at every point, in consequence of which it is said the rate of rise of the secondary voltage at break is particularly rapid, and the magneto, therefore, works satisfactorily at very high speeds. An interesting point about this magneto is that the spigot flange is cast integral with the body of the machine, giving a rigid mechanical construction. Various types of car magnetos are also shown. Another exhibit is the B.T.-H. impulse starter, one member of which is attached to a magneto spindle and the other to the driving shaft, the two being linked together by a helical spring. When the driving shaft is first rotated it brings the member attached to the magneto spindle against a stop, so that further movement of the driving spindle causes the helical spring to be wound up. After an angular movement of about 60 deg., the first member is released, and the armature thus receives a definite flick over, which gives a very intense spark and allows the engine to be started. This arrangement is particularly useful in conjunction with heavy engines, as no matter how slowly the crank handle is turned a good fat spark is obtained.

The Telephone Mfg. Company (Stand No. 127) are showing a complete series of their automatic inter-communicating telephones. Special mention may be made of the round call signalling system, which enables several officials to converse together simultaneously, so that a conference may be held without any of those concerned having to leave their offices. This is effected by an extra key on the intercommunication board, which connects the instruments concerned to a special circuit, and makes listening an impossibility. An instrument in, say, the manager's office can be fitted with small lamps to show which particular stations are engaged in conversation. In his way, why the office boy and the secretary's flapper are in communication can be ascertained. Reference may also be made to the auto-line finder instrument, which is in reality a semi-automatic exchange. Communication with any particular office is obtained by turning a dial switch to the appropriate number, pressing the call button and lifting the receiver. When the answering receiver is lifted a clockwork mechanism moves an arm over a series of contacts corresponding to the number of stations on the system. All these contacts are naturally dead with the exception of the one corresponding to the station initiating the call. When the arm reaches this contact a relay mechanism stops the arm, switches out the common return, so that the conversation can be carried on secretly over the lines of the two communicating stations, and indicates who is called to the called station. That a particular station is engaged is shown by the non-illumination of a signal lamp. We understand that the first installation of this system is nearing completion. Another interesting instrument shown is the Larynagaphone, which we understand is already proving exceedingly useful for mine rescue work, aviation and diving. This is illustrated herewith. Essentially it is a telephone with a throat transmitter such as was developed during the war for aeroplane work. The apparatus is equipped with a Morse signalling key so that communication can be maintained even when speech is not possible. The transmitter and receiver are made as far as possible of aluminium, and the whole apparatus is light and handy.



View of the Larynagaphone.

The Lodge Sparking Plug Company (Stand No. 26) were demonstrating the capabilities of their well-known plugs for marine and stationary engines by means of working exhibits illustrating the complete ignition gear for a large six cylinder engine and a small four-cylinder engine. Plugs were also exhibited by the Apollo Mfg. Company.

Messrs. Simms Motor Units (Stand No. 120) were showing a range of their well-known ignition specialities, including high-tension magnetos and sparking plugs.

Messrs. Smith & Sons (Motor Accessories) Ltd. (Stand No. 36), had, as is usual on these occasions, a comprehensive exhibit of their well-known accessories for internal combustion engine work. These included samples of the K.L.G. rustless sparking plugs, M. L. magnetos, lighting sets for marine work, electric telegraphs, and such other necessities or luxuries as compasses and nautical instruments, revolution indicators and fire extinguishers.

A selection of their well-known accumulators were shown by Edison Accumulators, Ltd., and a "Premier" electric welding set by Messrs. Jones, Burton & Company, Ltd.

Internal combustion engines included a new hot-bulb engine by Messrs. Norris, Hent & Gardeners, who also showed a number of their other types of engine for both petrol and paraffin working. Messrs W. H. Allen were also exhibiting a hot-bulb engine which possesses the interesting feature of a spherical combustion chamber. Of the internal combustion engines for marine and stationary work were to be found on the stands of the Aster Engineering Company, the Day Motor Company, Crossley Brothers, Ltd., J. I. Thorneycroft & Company, National Gas Engine Company, the Austin Motor Company, F. S. Bennett, Ltd., Green Engine Company, Ltd., Oil Power Company, J. W. Brooke & Company, Parsons Motor Company, Wm. Beardmore & Company, Ltd., Evinrude Motor Company, Perman & Company, Markt & Company, Hick Diesel Oil Engines, Ltd., Robey & Company, Babcock & Willcox, Fyfe Wilson & Company, the last showing two generating sets suitable for small power installations.

A 32,500 k.v.a. Waterwheel Generator.*

By R. B. WILLIAMSON.

This 32,500 k.v.a. generating unit for the Niagara Falls Power Company has been under construction during the past year by the Allis-Chalmers Mfg. Company. It is mounted directly above a 37,500 h.p. turbine, the two forming a close-coupled unit with a relatively short distance between the two machines. Thus, the shaft can be made short and stiff, and the combined unit has but two guide bearings, one at the top of the generator immediately below the thrust bearing, and the other directly above the waterwheel runner. To carry the generator, a large cast-iron barrel of heavy-ribbed design is bolted to the cast-steel speed ring of the turbine, thereby transmitting the weight of the generator through the barrel to the speed ring and foundation below the wheel. This shell forms a pit liner, and connects the wheel and generator rigidly together, insuring accurate alignment. The connecting barrel also supports the operating cylinders that control the gate opening of the wheel.

With these large vertical units it is necessary to provide brakes for bringing the machine to rest and for holding it in case of leakage through the wheel. The brakes are operated by air pressure and engage the lower surface of the field spider rim. Since the support for these brakes must take the whole weight of the rotating element, in case it is necessary to relieve the thrust bearing of the weight the brake support has been designed in the form of a conical cast-iron shell made in sections, and supported by the barrel connecting the wheel with the generator. This forms a strong compact arrangement, and the brake support incidentally forms an air enclosure under the generator to prevent the air discharged by the fans from passing into the wheel pit.

The generator is wound for 12,000 volts three phase, 25 ∞, runs at 150 revs. per min., and will be operated with neutral earthed through a resister. The machine has 20 poles. The general design does not differ greatly from that found in other large waterwheel machines. The speed of 150 revs. per min. is not so high as to introduce any unusual problems.

Based on the runaway speed of the waterwheel (approximately 85 per cent. overspeed), the stresses in the rotor will not in any case exceed one-third the elastic limit of the material. The rotor spider is made up of two wheels, each of which consists of an inner cast-steel spider, on which is shrunk a cast-steel field ring. Dovetail slots in the latter afford means for attaching the field poles, two dovetails being provided per pole. By this construction the field ring can be cast without local shrinkage stresses due to spokes, &c., because it is in the form of a plain ring made with uniform section.

The rings were cast with exceptionally large risers, and very universal castings were thus secured. Other advantages in making the rings separate are that they can be machined inside, thus ensuring better balance; moreover, any stretch due to centrifugal force does not cause local stresses in the inner spider arms. Each pole weighs approximately 3 tons; but the face of the rotor is so wide that the dovetail stresses are not more difficult to keep within safe limits than on many smaller machines. The total weight of the rotor with its shaft is approximately 265,000 lb., and the flywheel effect of the rotor is 10,500,000 lb.-ft. square. Including all parts, the machine weighs slightly under 300 tons.

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* Abstract of an article in the "Electrical World."

For the stator yoke the usual box frame design, made in sections, was employed to facilitate transportation and foundry work. The stator core will be stacked and the machine wound in the station. All parts have to be lowered over the cliff at Niagara Falls to the power house, and the machine was designed accordingly. The stator yoke will be surrounded by a sheet-steel casing, which will conduct the hot air discharged through the yoke openings to suitable ducts. Dovetail projections hold the stator punchings in the yoke, the iron sections varying from $1\frac{3}{4}$ in. to 2 in. in thickness. Ventilating ducts are provided in the usual manner. The inside diameter of the stator punchings was fixed largely by consideration of the shipment of the rotor parts and the use of a solid rim for the rotor-field ring. In this case the diameter is 16 ft. 4 in., and the peripheral speed is 7,700 ft. per minute. The outside diameter of the stator yoke is 21 ft.

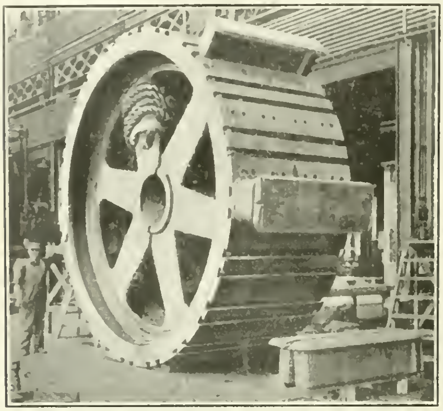

Fig. 1. Rotor Spider for 32,500 k.v.a. Generator, with a Field Coil and Pole in Place (25∾, runs at 150 r.p.m).

Two-layer winding with 15 slots per pole, or 300 coils in all, is used for the stator. The winding is arranged for Y connection, each end of each phase being brought out of the machine to permit the insertion of current relays and earthing of the neutral through a resistance. Although the temperature guarantees are those corresponding to class A insulation (A.I.E.E.), the coils are provided with mica insulation (Class B) both for the individual turns and also for the outer slot insulation, thus giving a large margin of safety.

While this unit has a very large output, the problem of supporting the ends of the stator coils against damage from short-circuits is not so difficult as in many machines of smaller output operating at high speed, as, for example, turbo-generators. The reactance of a relatively low-speed machine of this kind is high, in the present case about 20 per cent., and this limits the momentary short-circuit current to a safe value. Again, with a 20-pole machine the coils do not project such a great distance beyond the stator core as in higher-speed machines. In the present design the coils are securely blocked just where they project beyond the core to protect them against any side motion and consequent danger of breaking the insulation at the ends of the slot. They are also lashed to the insulated supports, as indicated in the accompanying sketch (Fig. 3). These supports are made in sections, and are bolted to brackets cast on the stator end heads. All metal parts near the coils are heavily insulated, and the supports themselves are arranged so that they cannot form conducting paths for stray currents induced by leakage fields from the winding. The diagonal parts of the coil ends are separated by blocking corded in place, and the method of support follows familiar practice.

In designing the three generators for this station the different manufacturers co-operated, with a view to having the external appearance and general dimensions correspond as nearly as practicable, so that the finished installation would present a uniform appearance. The upper bridge that carries the thrust bearing has eight radial arms, and is of cast steel made in two parts. Directly below the thrust bearing is the upper guide bearing, which is 22 in. in diameter and 36 in. in length. A Kingsbury thrust bearing, 49 in. in outside diameter and capable of carrying a suspended load of 465,000 lb., is provided. This has been ample to carry the weight of the rotor, waterwheel parts and downward hydraulic thrust on the turbine runner. Notwithstanding the heavy load supported by this bearing, the estimated friction loss is only 26 H.P. at 150 revs. per min. The bearing runs in an oil bath, through which oil supplied from a central system is circulated at the rate of 35 gallons per minute. Where the shaft passes through the thrust bearing it is 18 in. in diameter; at the centre of the rotor spider the diameter is 26 in. The shaft projects a short distance below the bottom of the machine, and is provided with a 15 in. diameter forged-on flange for bolting to a corresponding flange in the waterwheel shaft.

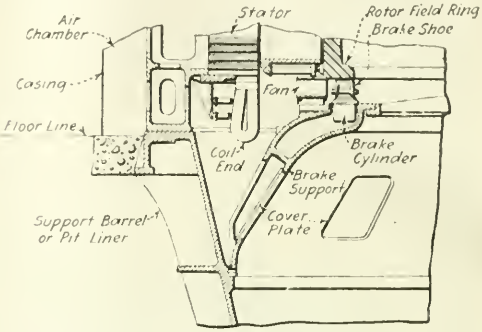

Fig. 2.—Cross-section through Lower Half of Generator and Pit Lines, showing Support for Brakes.

Special care has been taken to secure simplicity and reliability in design of the oiling arrangements. Oil supplied to the machine from the central system first passes through a duplex strainer; it then flows through separate branches of the feed pipe to the thrust and guide bearings, each pipe being provided with a regulating valve and a sight flow indicator. An oil meter is placed in the thrust-bearing supply pipe, and thermometers are provided for both thrust and guide bearings. Seamless steel tubing expanded into flange joints is used for the drain pipe. All oil-feed pipe is of copper with brazed flange joints.

As this generator requires approximately 80,000 cubic ft. of air per minute for carrying off the heat, the arrangements for handling the air required careful consideration. Air is taken in at the top and also from the pit underneath, and, after passing over the windings and through the stator core, is discharged into the casing surrounding the stator yoke. It then flows through ducts, and is forced out of the station by means of auxiliary fans. The rotor is provided with steel plate centrifugal fans on both top and bottom to force the air through the machine. A strong blowing action is also

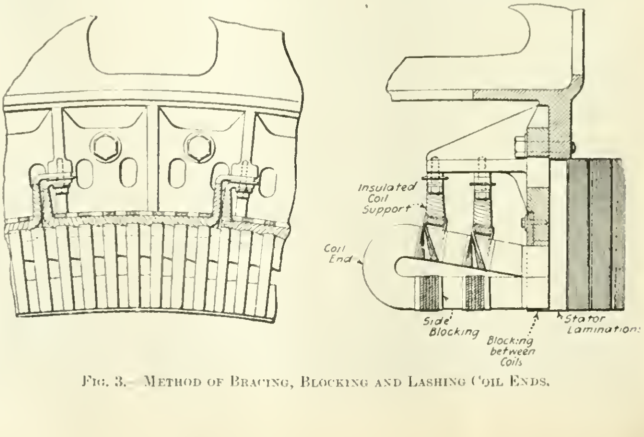

Fig. 3.—Method of Bracing, Blocking and Lashing Coil Ends.

exerted by the poles and the ventilating openings between the poles in the rotor rim.

From the foregoing it will be seen that, while this generator is of unusually large size, the design in general involves no radical departures from the usual lines for machines of this type. The aim has been to make a conservative design throughout, and at the same time obtain a highly efficient hydro-electric unit. Both of these objects are materially aided by the large output combined with moderate speed.

Lighting Conditions in Mines, with Special Reference to the Eyesight of Miners.

At the meeting of the Illuminating Engineering Society on February 24th a Paper on the above subject was read by Dr. T. Lister Llewellyn, assistant physician in the North Stafford Infirmary.

Dr. Llewellyn said that the source of light in coal mines giving the highest illumination was the tallow candle. This at least referred to lamps in use previous to 1914, none of which gave a light exceeding 1 c.p. A gradual diminution in the voltage of the battery of the electric lamp during the shift, and the nature of the atmosphere below ground in the case of oil lamps, tend to reduce the light below this figure. Another point of importance is the ease with which a candle can be brought quite close to the work, thus increasing the available illumination. The presence of dust, which quickly deposits on the glass of lamps, also tends to diminish the light. Up to 1914 the average illumination at the coal face in a pit, necessitating the use of safety lamps, was 0·018 ft.-candle; in mines where candles could be used the average illumination was as high as 0·09 ft.-candle.

Apart from its effect on safety in mines, the conditions of illumination have much to do with eyesight troubles, and in particular the development of the disease known as "miners' nystagmus." Dr. Llewellyn appeared satisfied that this is due primarily to the feeble illumination in which the men worked. The evidence available seemed to confirm the impression that the electric lamp commonly gave better results in this respect. A case was quoted of two pits in which, six years ago, nystagmus was equally common. After the introduction of electric lamps nystagmus became less frequent, and the output per person per shift was also 5 per cent. greater.

Dr. Llewellyn estimated that about 6,000 men were disabled every year through the disease, and that an economic loss of several million pounds was involved. Apart from the compensation for disablement, there is the strong probability that many accidents are caused by men failing to detect warning signs owing to failing eyesight. He suggested as a desirable standard an illumination at the coal face of 0·1 ft.-candles. The cost of providing such an illumination should be small in comparison with the economic loss that the prevalence of the disease entails.

Dr. H. S. Elworthy, in opening the discussion, confirmed Dr. Llewellyn's estimate of the minimum light required, but suggested that colour was also an important factor. Experience seemed to suggest that undue prominence of the violet end of the spectrum might have a prejudicial effect in very dark surroundings.

Dr. J. S. Haldane suggested that neurasthenia might be an important factor; but, in any case, the peculiar lighting conditions evidently increased the fatigue which contributed to the disease.

Mr. Robert Armitage, M.P., as a director of a colliery, referred to experiences with various forms of miners' lamps. As a result of introducing modern electric types nystagmus had been much reduced and work expedited.

Mr. Saufflebotham, an inspector of mines, thought that Dr. Llewellyn had, if anything, under-estimated the number of cases of nystagmus, and he agreed with Dr. Haldane that nystagmus was a general nervous disease.

Mr. E. Fudge, secretary of the Home Office Committee on Miners' Lamps, referred to various limitations which affected improvements in lamps, and also to the use of whitewashing, which was being tried in a number of pits with a view to securing better diffusion of light.

Mr. Hailwood remarked that about one-third of the lamps made by his firm were of the combustion type, and thought that with such lamps it should be possible to get an illumination quite as high as that obtainable with electric lamps. He agreed that good illumination was important; but existing data seemed difficult to reconcile, and he thought that there were other factors which had an influence.

Mr. J. George spoke as one having practical experience of work in mines. His hours at one time were from 6 a.m. to 6 p.m., so that he rarely saw the sun, and the soreness of the eyes he experienced was due to confinement in the darkness underground, which made bright illumination at first painful. This he believed explained why men considered the electric lamp dazzling if they had not previously used it; but their eyes subsequently became used to the brighter light.

Dr. D. L. Davis emphasised the fact that the eye symptoms in nystagmus formed a small part of a general disorder which could not be attributed to lighting alone; while Dr. T. Harrison Butler pointed out that the disease took 10 to 25 years for full development, and therefore a long time must be allowed to permit results of improved measures to be judged.

Dr. Harford referred to experiences in France, and said he had no doubt that defective illumination was the main cause of the disease.

Mr. V. V. Pass referred to some of the difficulties involved in obtaining a 4 c.p. lamp. The introduction of satisfactory small bulb "half-watt" lamps would be of great assistance.

Mr. Bernard Cridland urged the need for a representative joint committee to deal with the whole problem. The Council of British Ophthalmologists would be pleased to send delegates to such a committee.

Mr. L. Gaster (hon. secretary) mentioned that communications from Sir George Berry and others had been received, generally emphasising the important part played by illumination. He welcomed Mr. Cridland's suggestion regarding the formation of a joint committee, on which mining engineers, photometric experts and the medical profession should be represented. The problem resolved itself into first ascertaining beyond doubt the conditions of illumination responsible for the disease, and secondly in devising suitable lamps to provide this required illumination.

The Chairman (Mr. J. Herbert Parsons) remarked on the general belief that conditions of illumination were closely connected with the develop- of nystagmus, which seemed fully justified by the data given in Dr. Llewellyn's Paper.

Reviews.

Applied Optics: The Computation of Optical Systems being the "Handbuch der angewandten Optik" of Dr. Adolph Steinheil and Dr. Ernest Voit. Translated and edited by James Weir French, B.Sc. (London: Blackie & Son, Ltd.) Vol. I., pp. xvii.+170; Vol. II., pp. vi.+207. 12s. 6d. net each.

It has long been a source of regret to those interested in the position of both the practice and the theory of optics in this country that English books deal so inadequately with those properties of optical instruments which are of supreme importance to the optical designer. It is in the section dealing with aberrations that most of our present day problems—apart from those of a purely manufacturing character—lie. Our knowledge on these matters is far from complete, but the treatment to be found in our text-books of even this limited knowledge is very inadequate and at times directly misleading. For the most part our books have come from the universities, and the authors suffer from a too limited acquaintance with optical instruments and with the real problems that face the designer. Those that have hitherto been written by authors having wide practical experience within the optical industry have not been free from unfortunate conventions or other defects of treatment which have interfered with their general utility.

Attempts have been made to remedy these deficiencies by the translation of some of the more notable books of German origin. Among these translations the one now before us is by no means the least important. Of the two authors one represents the academic side of the subject, the other the manufacturing side. This arrangement should enable the one author to fill up the shortcomings of the other, but such an expectation, as in the present case, is not always fulfilled. The aim of the writers was originally to produce a work covering the whole ground with which the manufacturer is concerned, but only one volume of the three then contemplated has ever appeared. In the translation this volume has been published in two parts. The first deals principally with the more elementary properties of optical systems and with the aberrations of single lenses; the second with the calculation of compound lenses and the measurement of refractive indices. An important feature of each volume is the complete detailed working of illustrative examples, and a statement of the results reached by similar treatment of other systems designed to form a number of complete series of single lenses and of achromatic objectives corrected for spherical aberration. These series lead to a number of general conclusions with which every designer of optical instruments must be familiar. It is these exact calculations, together with the collection of detailed formulæ for tracing rays trigonometrically through a system of refracting surfaces in all the various cases which may arise, which constitute the valuable features of the book. The formulæ and the system of numbering the surfaces devised by the authors endures down to the present day as the one most extensively adopted by optical workers. They have, of course, been constructed for facility in use in connection with logarithmic tables, and are not necessarily the most convenient when calculating machines are employed. In spite of the presence of errors in the formulæ and in some of the numerical examples (which have unfortunately not been corrected in the translation) these features are of sufficient permanent value to ensure an extensive demand for the book.

As regards the rest of the book it is not possible to speak so favourably. The advantages that might have been expected from the co-operation of two authors with such qualifications as Steinheil and Voit possessed have not been realised. The formulæ are not always strictly algebraic, the positive sign occasionally being intended to be employed in an equation for a negative quantity—a feature that is present in some other well-known German optical treatises. Aberrations of entirely distinct characters are confused with one another. General deductions are drawn from series of numerical calculations which these calculations themselves show to be false. In brief, the book, like much of the technical optics of to-day, suffers from exclusive adherence to the trigonometrical method of investigation and the entire neglect of any other method of investigation whatever. To take an example, the authors treat coma as a zonal variation of focal length, a view which any analytical method of separating aberrations shows at once to be untenable, but which is nevertheless widely held.

The unevenness in the character of the whole work is so pronounced that the only way in which a satisfactory introduction to the calculation of optical instruments could be derived would be by writing an entirely new book on the subject, and extracting the more valuable portions from the original. Such a course is hardly open to any editor in translating a technical work, and was in any case out of the question at the time this translation—which was primarily undertaken as a war measure—was prepared. The difficulty has been met to a limited extent by the addition of editorial notes, but these could with advantage have been much more numerous. Apart from this fault and the retention of algebraic and arithmetical errors, which should be remedied in a second edition, we have nothing but praise for the manner in which the translation has been made. The English is clear and well written. A desirable innovation is the use of line diagrams in different colours. The principal formulæ, together with lists of the symbols used and a statement of the conventions adopted are printed at the beginning of each volume. Not the least important improvement on the original consists in the addition of a very complete index.

The book is well printed on very thick paper. It will be found very valuable as a work of reference for the computer who has already a knowledge of optics, but with the existing errors it cannot be recommended by itself as a safe introduction to the calculation of optical systems for either the student or the would-be computer. T. S.

The Manufacture of Chemicals by Electrolysis. By A. J. Hale, B.Sc., F.I.C. (London: Constable & Co.) Pp. xi.+80. 6s. net.

This volume is one of a series forming a "Treatise of Electro-Chemistry" of which Mr. Bertram Blount is editor. We believe this is the first to appear.

The subject may be described as the manufacture of the finer chemicals as distinct from those, such as soda and bleach, which are required in large quantities. Thus the products include electrolytic oxygen and hydrogen, per-salts, hydroxylamine pigments and bodies produced by electrolytic reduction and oxidation.

The author gives much useful information and has brought together results which hitherto have been available only in a scattered literature. There are, however, two general criticisms we should like to make. The first is that the reader is often left in doubt whether a process is really being worked commercially or is merely the subject of a patent. The second is that the author does not always define what he means by cost. For example, the cost of electrolytic oxygen by a certain plant is stated to be 5d.-6d. per cub. metre, but it is not explained whether this is merely the cost of electric energy on a certain basis or whether it also includes labour, maintenance and capital charges.

In a second edition we hope that the author will amplify the work in these directions. Meanwhile the present volume will prove a useful addition to the existing literature.

The Aviation Pocket Book for 1919 20. By R. Borlase Matthews. (London: Crosby, Lockwood & Son.) Pp. xxiv.+535. 12s. 6d. net

This is the seventh edition of a book that has appeared annually since 1912: it has been greatly enlarged and improved in the course of years, and among the new features in this edition is the introduction of the De Da (Detachable Data) System, patented by the author, to facilitate the detaching from the book and filing in a loose leaf book of any data that one wishes to keep handy for reference a very useful innovation. Among the new items, attention may be drawn to tables of A.G.S. parts, giving an alphabetical index of A.G.S. numbers of standard metal parts for aeroplanes and standard screw threads used in aircraft construction. The notes on parachutes are also new, and give much information on a subject of which not much is generally known. The chapter on meteorology is very much enlarged, and is full of useful figures and information. There is also a short description of the electrical apparatus carried on an aeroplane and used for lighting, heating, signals, &c. Besides being a useful work of reference to the engineer or student, it contains much reading matter of interest to the aeronautical amateur, and should prove particularly fascinating for those interested in figures, who, for instance, could tell off-hand the respective wing loading of a gnat, a cockchafer or a vulture. Anyone who studies it will be equipped with a mass of miscellaneous information. Of course, a book of this sort takes a long time to compile, and the information about aeroplanes cannot be quite up to date. The bibliography leaves something to be desired in the way of completeness and discrimination.

Correspondence.

THE TREND OF ELECTRICAL EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Prof. Marchant seems to think that the soundest tendency in educational institutions is to specialise in fundamental principles. It seems to me that this should not only be a tendency, but the sole aim of such institutions. What educational institution can claim to do more? The financial side ought not to enter in at all; in the first place, because it cannot be properly taught, inasmuch as teachers themselves are usually ignorant of this side of the subject, and, further, there are too many problems of a scientific nature on which the time of students could be more profitably spent. It would be far better to recognise at once that there are certain aspects of an engineer's training which belong to the works, and only there can he gain the necessary experience. The average student already has to cram much unnecessary matter, without worrying about scientific management, contracts and specifications, &c. What is necessary is to stimulate the student's mind to think of the many and varied problems that await solution, and to give him time to reflect and study. I fail to see any grounds for congratulation on "the large number of important positions now being filled by men with an engineering education." The majority of men find that education forms a very small element in a man's success. The majority of men that I know who hold important positions cannot claim that. It would be interesting to know how many men in large organisations hold important positions on that score. The average man finds that personal relations, bluff, long service, &c., are much more important factors. For every man who holds an important position through his education I undertake to find him a hundred equally as well educated—who are earning less than the average manual labourer. The educated man, as a rule, finds his reward in the joy that his education gives him. That joy, that incentive to study fundamental principles and apply them to useful purposes, will be eliminated immediately considerations of finance enter. I am, &c.,

Bristol, March 14. H. Vickers.

The Electrician.
FRIDAY, MARCH 19th, 1920.
Price ONE SHILLING. By Post 1s. 1d. Ann. Sub.: U.K. 52s. Abroad 54s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benhrotric Fleet London."

Tramway Finance.

We referred recently to the alarming financial condition of many of the municipally-owned tramways of this country and the condition of the London County Tramways, as disclosed in a recent report of the Highways Committee, is not the least alarming. Instead of it being possible at the end of the present financial year to add a substantial sum to the renewals and reserve fund, it is now found that as the receipts will be considerably less and the working expenses more than was expected, it will be necessary to drain both funds to such an extent that they will show a deficit. The question to be solved is how so unsatisfactory a state of affairs is to be dealt with.

That the present financial position is not of a temporary character and is not likely to be improved unless definite action is taken is evident when the facts of the case are considered.

Interesting Comparative Figures.

In 1919-20 wages had increased 167 per cent. as compared with 1913-14, in spite of a smaller car-mileage being worked, or to 11·15d. from 4·14d. per car-mile. In the same period fuel had increased from 0·59d. to 1·71d. and other expenses, including war allowances, from 1·77d. to 3·68d. per car-mile. The total expenditure per car-mile is now 16·54d. against 6·50d. in 1914. In the same period the passenger receipts per car-mile had risen from 8·94d. per car-mile to 18·87d.; a percentage increase of 111·07 per cent. as against an increase of 154·46 per cent. in expenses. And while the receipts per passenger have increased by 44·55 per cent., the average cost per passenger has increased by 75·34 per cent. Such a state of things obviously cannot continue without disaster, and the Committee therefore recommended that a further increase in fares should be made.

An Obvious Conclusion.

The financial position of the L.C.C. Tramways has also been considered from a rather different point of view by the Advisory Committee on London Traffic of the Ministry of Transport in an enquiry conducted by them at the end of last year. The conclusions come to were that there would be a deficiency of £137,000 for the year ending March 31 next, and that this would increase to £580,000 in 1920-21. As working expenses are not likely to be reduced, and expenditure on renewals will certainly be heavier, if financial equilibrium is to be preserved, the revenue of the undertaking must be increased. This conclusion, though both obvious and simple, has so often been neglected in the past that it is worth while calling special attention to it.

A Short History of the Undertaking.

We hope that a certain old proverb about too many cooks spoiling the broth is not applicable to the L.C.C. Tramways. For whatever its shortcomings it does not lack advisers. The Finance Department of the Ministry of Transport has also issued a memorandum which, delving into ancient history, shows that up to 1911-12 the net revenue obtained by the undertaking was sufficient to provide for fixed charges and renewals on the basis in the latter case, of ⅔d. per car-mile, while it was also possible to build up a reserve fund. Our readers will remember that this is not the first time the condition of the L.C.C. tramways system has been critically examined by financial experts. For it is 12 years ago almost to a week since we published a report by Messrs. W. B. Peat and F. W. Pixley, in which, while reviewing the situation generally, they recommended that an amount equal to 1d. per car-mile should be placed to the renewals fund. The amount actually put by had been very much lower, and as we showed at the time even the amount suggested was less than the sums allocated in such well-known tramways centres as Manchester, Liverpool and Glasgow. The Council, however, while adopting the spirit of the advice, neglected the letter and only allocated ⅔d. per car-mile. We fear that the present state of affairs is not a little due to this advice being neglected. For people who do not prepare for a rainy day must not be surprised if they get wet.

Proposed Remedies.

We have dwelt for some time on the condition of the undertaking. But what are the remedies? The Finance Department of the Ministry of Transport suggests that by reducing the present charges for street improvements, by relieving the tramways from the rating on the tracks and the cost of maintaining the roadway, some improvement might accrue. It has also suggested that relief might be obtained in respect of debt repayment charges if an annuity basis were substituted for the instalment system, or by charging to capital the difference between cost of renewals effected and the debt remaining to be repaid in respect of the original work. Two further remedies are the elimination of competitive omnibus services and the increase of fares. Quite apart from ethical considerations it is doubtful whether the removal of omnibus competition would have the desired result. The tramways and the omnibuses together cannot carry the passengers who wish to travel, and forcibly to prevent the latter operating can hardly have the effect intended. Perhaps, however, the suggestion was not made seriously. The proposed financial remedies would have but a small effect, and also require legislative sanction before they can be put into operation. The only thing left is to raise the fares. This it has been decided to do within the statutory limits after a discussion tinged with acrimony which we now expect when tramway matters are under consideration in the Council. The most relevant objection raised to the proposed increase was that the whole matter had been discussed without a full knowledge of the facts. Such extraordinary expenditure as that caused by the liberal allowances made to men absent on military service and overdue repairs carried out during the past year, had, it was considered, not been sufficiently taken into account, and for that reason it would be better to postpone any further increase in fares for the time being. There is a good deal to be said for this course, but the Council preferred to take drastic action.

The matter is, or rather ought to be, purely one of finance, and it is a pity that politics are introduced where they are not required. It is, nevertheless, not a little amusing that those two doughty opponents, the London County Council Tramways and the London Traffic Combine, are both suffering from the same disease. In one case the ratepayers suffer and in the other the shareholders. But of the two the former are the more unfortunate as the deficit is made by a forced levy on their pockets as and when it may be required. We should like to see the fares adjusted so that with sound financial operation the undertaking may be placed on a firm foundation and we hope that politics will not be allowed to prevent this being done.

Electric Lamp Industry.

The findings and decisions of a Sub-committee appointed by the Standing Committee on Trusts to inquire into the existence of any trust or trade combination in the electric lamp industry, have been published and have been adopted by the Standing Committee.

The members of the Sub-committee were Messrs. John Hilton (chairman), J. E. Baker, M.B.E., M.A., LL.B., F. J. Blakemore, F.C.I., M. A. Leveaux, R. S. Pengelly, and W. H. Watkins, with Mr. Percy Gents, as secretary.

The first part of the Sub-committee's report is devoted to a history of the developmens of the electric lamp industry. Prior to the war, the annual output of incandescent electric lamps in this country is estimated to have been about 25,000,000, the corresponding figure for the United States being 110,000,000, for Germany 100,000,000, and for Holland 16,000,000. During the war the American output is stated to have increased by 60 per cent., and the British output by 20 per cent., while the manufacturers of Holland have gone rapidly ahead, and acquired a considerable part of the foreign lamp trade of both Britain and Germany. In 1913 electric incandescent lamps to the number of 3,300,000, having a value of £196,000, were imported into this country; while 3,700,000 lamps, valued at £192,000, were exported. During the war imports have shown an increase and exports a decline. In 1919 the lamps imported totalled over 2,500,000, and those exported over 2,800,000, the f.o.b. value of the exported lamps being, however, only about two-thirds the c.i.f. value of the imports. The consumption of lamps in the United Kingdom is now estimated at 30,000,000 per annum.

Existence of Combination.

We find that a trade combination does exist among electric lamp manufacturers in this country, and exercises a powerful influence over the conduct and development of the industry. The Tungsten Lamp Association was formed about seven years ago; its declared objects being to promote and protect the interests of manufacturers of and dealers in electric lamps in the United Kingdom; to conduct and assist in making experiments and research for the improvement of electric lamps; and to enter into agreements with members and wholesale and retail dealers relating to the manufacture, supply and sale of electric lamps. The success of the first metal filament lamps made in this country, under acquired German and Austrian patents, encouraged other electrical concerns to make researches and take out patents for new inventions. It was considered that some of these patents overlapped, and costly litigation was threatened. Deeming co-operation preferable to conflict, the British Thomson-Houston Company, the General Electric Company, and, later, Messrs. Siemens, came together, primarily on patents, each agreeing to recognise the others' patents and to license the others for its own patents, and to interchange factory and laboratory experience. As a natural consequence, we are informed, a selling arrangement was entered into. These three, with the Ediswan Electric Company, formed themselves into the Tungsten Lamp Association. This Association was incorporated in the Electric Lamp Manufacturers' Association of Great Britain in April, 1919, the declared objects of the latter Association being the same as those of the original Association. Various other firms have joined the Association since its formation, and these are now members of it. The non-associated firms include: Cryselco Lamp Company, Crowther & Osborne, Ltd. (Secondo Lamp Company), Imperial United Lamp Company, Corona Lamp Works, Ltd., Harlesden Lamp Company (Stella Lamp Company), Maxim Lamp Works, Ltd., and the Notable Lamp Company, Ltd. Prior to the war the Association was responsible for about 85 per cent. of the total British output, whilst for last year their proportion is estimated to be between 90 and 95 per cent.

Effect of Combination.

The Electric Lamp Manufacturers' Association has an arrangement whereby its members fix a common retail price for the various types and grades of lamps sold to the public, and give an agreed rate of discount to the factors and retailers who handle the lamps. A basic discount of 20 per cent. on retail selling prices is allowed to any approved trade retailer. The Association has further a sliding scale whereby any trader doing business in Association lamps to the amount of £70 or more per annum can receive a discount proportionate to his total annual purchases of lamps from all the associated firms, the rates varying from 22 per cent. on £70 nett value of purchases to 39 per cent. on £56,000. If a trader desires and is entitled to more than 20 per cent. discount under the above scale he must apply to the Association for grading, which is granted conditional on his signing an agreement. A condition of sale of all Association lamps is that they shall be sold to the user at the prices fixed by the Association. This "list prices nett" register, which appears to be known in the trade as the "Black List," contains the names of about 100 firms. A manufacturer of electric lamps who is not a member of the Association has the normal channels of the distributing trade in large part closed to him. The position of the non-Association manufacturer is likely to be even more difficult in the future than hitherto, by reason of the introduction of the Half-Watt lamp.

The evidence we have heard goes to show that in the existing state of the lamp market the retail prices fixed by the Association become the standard retail prices for all lamps, whether manufactured by Association or non-Association firms. Whilst non-Association manufacturers allow greater dscounts to the middleman, their lamps are bought by the general public at the same prices as Association lamps. There is no prospect of the prices fixed by the Association for lamps sold to the general public being subjected to any effective competitive check (so far as the non-Association lamps made in this country are concerned) until such time as the supply of electric lamps considerably exceeds the demand.

Foreign Competition Unlikely.

Nor would foreign lamps, even assuming open ports, easily find their way through the normal distributive channels, for it is to be noted that the agreements under which the vast majority of distributors handle Association lamps are directed against imported lamps (except such as may be imported by the Association) equally with non-Association lamps manufactured at home. In one respect potential competition from abroad is more formidable than home competition. American, Dutch and perhaps German manufacturers, in that they have far greater financial backing or may be able to produce at far lower cost, might have an inducement and a power to challenge the Association monoply in Great Britain to better purpose than any non-Associated home manufacturers, but from evidence laid before us we incline to the view that an international agreement between the British, American and Dutch Electric lamp combines might forestall any threatened battle royal between the respective national groups.

Factory Price of Lamps.

We have next sought to ascertain the prices obtained for Standard Vacuum Lamps by Association and Non Association manufacturers from the trade or from large users. Lamps bought by the public at 3s. have been sold, presumably at a profit, by the manufacturers to the trade or to large users at approximately 1s. 6d. and 1s. 3d. But these are not wholly representative figures, in that the *average* discount given is something less than the *maximum* discount. Our inquiries as to the *average* price received by manufacturers over the whole range of their sales have adduced information which we cannot verify and which does not lend itself to presentation in a form permitting of unquestionable deductions. We must, therefore, be content to record that we have been furnished with information indicating that the average price received for standard vacuum type lamps, with drawn lamps filaments, by four of the largest Association firms, was 1s. 8½d. in 1913 and 2s. 2d. in 1919. A table of prices for various periods from 1912 to the present day and a table of prices of association and non-association lamps are given. From the two tables we draw the following inferences:—(*a*) that non association firms, although their output is in general smaller than that of the association firms, are able to sell lamps at a lower price than association firms and still make a satisfactory profit on their manufacture; (*b*) that because of the standard price policy the public was compelled to pay the same price for non-association and association lamps, the whole price-advantage of the former (which to the factor was 9¼d. in 1912 and 2¾d. in recent years) being denied to the householder.

Since the beginning of the war the price to the public of the standard vacuum lamp has been increased by about 26 per cent. As the general retail price level of necessaries has risen during the same period by 125 per cent., it follows that the price of electric lamps has been advanced much less than the price of commodities generally. The Report proceeds to deal with the cost of production, profits, patents, licences, &c.

Export.

We find that the Association does not control the output or sale of lamps for export, except for the U.S.A., Japan and Mexico. We are of opinion that if lamps can be sold for export at such low prices and sold at a profit to the maker, it should be possible to reduce prices to that extent in the home market, irrespective of reductions on other counts.

Import of Lamps.

It is stated that during the first seven months of 1919 licences for the importation of Dutch half-watt electric lamps were issued by the Board of Trade, on the recommendation of the Ministry of Munitions, to the following firms:—British Thomson-Houston Company, 250,000 lamps, Siemens Bros., 500,000, and the General Electric Company, 500,000 lamps.

The report also deals with mass production, international arrangements, &c., and winds up with the following conclusions:—

Conclusions.

(*a*) There is in the electric lamp industry a trade combination—The Electric Lamp Manufacturers' Association which includes from 90 per cent. to 95 per cent. of the industry, controls factors and retailers, fixes prices at all stages and regulates output.

(*b*) The prices fixed by the Electric Lamp Manufacturers' Association become the standard prices for all lamps sold in this country, whether made by Association or non-Association manufacturers, or imported from abroad.

(*c*) British lamp manufacturers outside the Association produce and sell to the trade (presumably at a profit) lamps of comparable quality at a lower price than Association firms.

(*d*) Because of the standard price policy originated by the Association, non-Association lamps are sold to the public at the same price as Association lamps, the advantage on the lower-priced lamps going wholly to distributors. Hence, either Association manufacturers are making an undue profit, or they manufacture less economically than non-Association makers.

(*e*) The trading discounts received by factors and retailers are considerably higher than is necessary, and should be reduced.

(*f*) Standard vacuum lamps now sold to the public at 3s. could be sold at 2s., at which price the manufacturer and the distributor would still have a satisfactory working profit.

(*g*) One and a quarter million half-watt lamps, sold to the public in

1919 at 12s. 6d., were purchased in Holland by the three associated manufacturers at about 3s. per lamp.

(*h*) These half-watt lamps could have been sold to the public at not more than 8s., which price would still have left ample margins for the importers and distributors.

(*i*) The Electric Lamp Manufacturers' Association has been created primarily in the interests of three firms The British Thomson-Houston Company, the General Electric Company and Messrs. Siemens Brothers. These impose onerous conditions upon other firms in the Association, *e.g.*, a limitation of output upon licencees, and a stipulation that the validity of their patents shall not be questioned or disputed.

(*j*) The limitation of output imposed upon licencees is contrary to the best interests of the industry and of the consumer.

(*k*) Since the largest of the three dominant firms in the Association is under majority control of an American electrical concern, there is some danger of the interests of the British lamp industry being subordinated to American interests.

(*l*) There is a possibility of an international combination, comprising British, Dutch and American manufacturers, which would be able to control supplies and dominate prices over a considerable part of the world.

(*m*) The operations of an Association which so effectively controls an important industry should be subjected to public supervision and control; and we consider this would best be attained by giving statutory effect to the recommendations of the Committee on Trusts appointed by the Minister of Reconstruction.

New Mines Regulations.

The Home Office has prepared a draft of general regulations which it is proposed to make under sec. 86 of the Coal Mines Act, 1911. The regulations fall into six parts. The first deals with precautions against dust, the second with precautions against spontaneous combustion of coal, and the third includes additional provisions as to the design and testing of rescue apparatus, &c.

Part four, which deals with electricity on the surface, provides for the extension and adaptation of the present regulations for the use of electricity underground to apparatus used above ground, which at present is not in general subject to regulations. The precautions to be taken where coal or other mineral is being worked or roads driven under moss, quicksand or other liquid matter, are dealt with in part five; and the concluding part deals with miscellaneous matters.

The regulations are issued as a draft, and general or local objections made before April 12 will be referred to a referee.

It is proposed to apply Part III. (Electricity) of the General Regulations of the 10th July, 1913, to apparatus used above ground, subject to the following amendments:—

1. In Regulation 118 and sec. (*c*) of Regulation 131, the words "at the surface of the mine" shall be substituted in every case for the words "in the mine."

2. Regulations 119, 120, 121 (iv.), 122 (*b*), 123 (*b*), 128 (*a*), 132, 133, 134 (*a*), 135, 136 and 137 (*b*) shall not apply.

3. For Regulation 123 (*a*) the following regulation shall be substituted: "Where necessary to prevent danger or mechanical damage, apparatus shall be placed in a separate room, compartment or box of fireproof construction. Inflammable or explosive material shall not be stored in any such room, compartment or box."

4. The word "regulation" shall be substituted for "rule" in the second paragraph of Regulation 125 (*c*).

5. For Regulation 129 the following regulation shall be substituted: "Unless so placed or otherwise safeguarded as to prevent danger, all cables other than flexible cables for portable apparatus and signal and telephone wires shall comply with the following requirements: (*a*) They shall be covered with insulating material (except that the outer conductor of a concentric system may be bare). The lead sheath of lead-sheathed cables and the iron or steel armouring of armoured cables shall be of not less thickness respectively than is recommended by the British Engineering Standards Association. (*b*) They shall be efficiently protected from mechanical damage and supported at sufficiently frequent intervals and in such a manner as adequately to prevent danger and damage to the cables. (*c*) Concentric cables, or two-core or multi-core cables protected by a metallic covering or single-core cables protected by metallic covering which shall contain all the conductors of the circuit, shall be used (i.) where the pressure exceeds low pressure, and (ii.) where there may be risk of igniting coal dust or other inflammable material. (*d*) Cables unprotected by a metallic covering shall be properly secured to efficient insulators. (*e*) The metallic covering of every cable shall be (i.) electrically continuous throughout; (ii.) earthed, if it is required by Regulation 125 (*a*) to be earthed, by a connection to the earthing system of not less conductivity than the same length of the said metallic covering; (iii.) efficiently protected against corrosion where necessary; (iv.) of a conductivity at all parts and at all joints at least equal to 50 per cent. of the conductivity of the largest conductor enclosed by the said metallic covering; and (v.) where there may be risk of igniting coal dust or other inflammable material so constructed as to prevent, as far as is practicable, any fault or leakage of current from the live conductors from causing open sparking. (*f*) Cables and conductors, where joined up to motors, transformers, switchgear and other apparatus, shall be installed so that (i.) they are mechanically protected by securely attaching the metallic covering (if any) to the apparatus; and (ii.) the insulating material at each cable end is efficiently sealed so as to prevent the diminution of its insulating properties. Where necessary to prevent abrasion there shall be properly constructed bushes."

6. The second paragraph of Regulation 131 (*f*) shall not apply.

7. For Section (*h*) of Regulation 131 the following shall be substituted: "The person authorised to work an electrically driven portable machine shall not leave the machine while it is working, and shall, before leaving the machine, ensure that the pressure is cut off from the flexible trailing cable which supplies such portable machine. Trailing cables shall not be dragged along by the machine when working."

8. In Section (i.) of Regulation 131 the words "repaired or" shall be inserted before "replaced." The last sentence shall not apply.

9. In Regulation 134 (*b*) the words "used for signalling" shall be inserted after "contact makers."

The London Fair and Market.

The London Fair and Market, which opened at the Agricultural Hall on Tuesday and continues open until Friday next, is a trade market to which the public are not admitted, and is intended solely for the transaction of wholesale business. There are there exhibited not only the products of leading British firms, but also goods manufactured in France, America, Japan and other countries. It is, therefore, hoped that the exhibition will serve to bring before English manufacturers new markets and sources of supply.

The number of exhibits of direct interest to electrical firms is, however, small, the most important of these being that of Messrs. Siemens Brothers & Company, who are showing a number of their well-known primary cells and batteries for telegraph, telephone and other similar "weak current" work, together with carbon lamps for all classes of electric lighting. The Ebonestos Manufacturing Company are exhibiting moulded articles for all classes of electrical work, while the British Ever Ready Company have a selection of their well-known electric pocket lamps and torches. Electric vacuum cleaners are to be found on the stand of the Gem Labour-Saving Device Company, while electric toys which will be suitable for children of all ages are exhibited by the A. C. Gilbert Company. The Indian & Colonial Supply Association, Albert Leigh & Company, the Remoline Company, William Soutar & Sons, and the United Merchants, Ltd., also have examples of various classes of electrical apparatus on view. A selection of publications issued by Messrs. Benn Brothers, Ltd., will also be found of interest.

Rotary Snap Switches.

A matter of interest in electrical design is the way in which rotary snap switches are now coming to the fore for the reason that they enable many switching operations, hitherto only effected with difficulty to be performed with ease. This statement is particularly true when applied to the control of heating and cooking apparatus. The relatively large currents used by this equipment necessitate the provision of switches with as long and rapid a break as it is possible to obtain consistent with small dimensions and neat design. These conditions are fulfilled by the rotary snap switch, and further, by a simple arrangement of inter-connections a three degree heat control can be effected through a single switch a condition almost impossible of attainment with the ordinary tumbler switch.

It is therefore interesting to note that the General Electric Company have accepted the sole agency in this country for the "H. and H." Hart rotary snap switches and other specialities produced by the Hart & Hegeman Manufacturing Company of Hartford, Conn., U.S.A., and that arrangements have been made whereby representative stocks will be held by the General Electric Company at their various branches throughout the country. We understand that a descriptive "H. & H." Hart switch catalogue is in course of preparation, and as soon as available it will be sent to those applying.

An appeal is being made for a fund of £1,000,000 for Liverpool University, in order to bring the equipment of the laboratories, &c., up to date. At a public meeting, over which the Lord Mayor presided on the 11th inst., contributions and promises of over £200,000 were given. The Vice-Chancellor said that some of the laboratories had been in existence since 1881 and were lamentably incomplete, and for this alone they needed £350,000. To meet the needs of the University £1,000,000 was wanted; about £500,000 was immediately asked for. Sir William M'Cormick, Chairman of the Advisory Committee on University Grants, said that in the coming autumn his Committee were to prepare a report for the Government on the question of further grants for the universities. The best argument they could use would be the success of this appeal, for the locality must do something and not leave all to the taxpayer.

Legal Intelligence.

Direct United States Cable Co., Ltd. v. Western Union Telegraph Co.

Mr. Justice Peterson last week gave judgment upon the summons taken out by plaintiffs for the relief under the Defence of the Realm Act in respect of powers purported to be exercised by defendant company under a penalty clause in a lease granted to the latter of a cable to America. His Lordship said that this was an action under the Courts Emergency Powers Act for the purpose of obtaining a declaration that defendants were not entitled to determine a lease of certain cables. Defendants had the right of working various trans-Atlantic cables, and in March, 1912, plaintiffs leased to them one of their cables for 99 years at a rental which amounted to between £60,000 and £70,000 per annum. Plaintiffs undertook an obligation to carry out repairs, the clause under which the undertaking was given provided that they should, at their own cost, maintain the Direct Company's cable in proper working condition, and renew as it became worn out or destroyed. Then it was provided that in the event of any interruption continuing for more than 12 months, half of the rent should cease to be payable, and in the event of the interruption continuing for more than 18 calendar months the whole of the rent should cease to be payable until the cable was repaired and communication restored. It was further provided that in the event of such interruption it should be lawful for the Western Union Company to give notice for the determination of the lease, and to claim damages. On the interruption taking place it was notified in due course, but the cable was not repaired until after the expiration of 18 months, and defendants accordingly gave notice to determine the lease, and the question now was whether the plaintiffs were, under the circumstances, entitled to relief. A break occurred in 1918, and it was proved that deep sea repairs could not be executed during the winter months, which rendered it impossible to remedy breaks which had occurred in 1917-18. In October, 1917, plaintiffs made inquiries of the owners of a repairing vessel, but they were not prepared to make an agreement so far ahead. In 1918 there was a meeting with the Admiralty to arrange for the repairs, and the Admiralty suggested a programme by which all the cables should be put into operation before November, 1918. His Lordship, having referred in detail to the negotiations which had taken place with the Government for getting the cables repaired, said that the plaintiffs' first contention was that the case came within sec. 2 of the Courts Emergency Powers Act, 1917, which limited the carrying out of any contract. The lease in this case was no doubt a contract of continuity within the section, and it was argued that plaintiffs were bound to repair the Eastern break. It was not suggested that they did not make the repairs with all possible despatch, but the circumstances were such as prevented the completion of the repairs within the 18 months. It was said that the Admiralty orders restricted the repairs, and their failure to allow the repair ship to do the work was the cause of the cable not being repaired. Defendants contended, on the true construction of the clause, the only breach would be if plaintiffs did not use all despatch in carrying out the repairs after having received notice. He did not find it necessary to determine this question. In his view, the decision of the Admiralty at the meeting in February, 1918, could not properly be described as an interference with the navigation of the repairing ship. It was necessary for plaintiffs to show that failure to repair was attributable to the Admiralty orders, but it could not be said that the orders were responsible for the failure to repair. The order was made for the purpose of assisting, and not restricting, repairs. He was not satisfied that the failure to repair could be properly attributable to the decision of the Admiralty. The shortage of ordinary merchant ships must be disregarded, as the ships required were cable ships, and there was no evidence that cable ships were diverted to other purposes, and he could not say that there was a shortage of cable ships or that the damage to the cables, or the insufficiency of cable ships was attributable to the war. It was contended that there was a shortage of cable ships because one of the cable ships had been taken for the repair of a German cable which the British Government had taken possession of, and it was argued that that was the result of the war; but that contention had not been established. In his opinion, plaintiffs' claim to relief under sec. I failed. Another section upon which plaintiffs relied was that which provided for a case in which a contract could not be enforced without inflicting serious hardship upon one of the parties to it; but in his opinion that also failed. Therefore plaintiffs' application failed, and it would be dismissed, with costs.

A stay of execution was granted in view of appeal.

The relative advantage of a colliery or a group of collieries generating their own power or purchasing it from an outside source, was discussed at a meeting of the Midland branch of the Association of Mining Electrical Engineers at Manstead on Saturday. Mr. A. W. Williams said that the first point that would impress a colliery engineer would be that it was impossible for a large supplier to generate power and supply it at a lower rate or give a better service than the colliery company, who had the main product with which to raise steam on the premises; but there might be instances where advantages would be gained by taking independent supply. While the taking of supply from outside sources would release a colliery company from the responsibility of maintaining generating plant and enable power to be taken as required. On the other hand there would be the disadvantage of lack of knowledge as to the condition of the generating plant, which was important.

Mr. W. Wymess thought the idea of linking up existing power plants was a good one, especially if the coalowners would meet to discuss the matter from a national standpoint.

Commercial Topics.

A Municipal Wiring Scheme.

Though the London Borough Councils have authority under Part V. of the London County Council (General Powers) Act to wire consumers premises and provide and let on hire motors and fittings, only two or three Councils have taken advantage of the powers. Shoreditch Borough Council has now authorised its Electricity Committee to prepare a scheme for supplying consumers' premises with wires, fittings, motors and apparatus. The power to hire out apparatus is very useful, but we hope, however, that the Council will not embark on competition with local wiring contractors.

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German Export Restrictions.

It is announced that the Central Bureau for Export Permits of Berlin will in future grant no permits for the export of machine tools unless the basic prices which prevailed in January last are increased by 600 per cent. The Bureau also recommends makers to include in their offers a reservation that if the quotation for the dollar in Berlin stands higher than 80 marks on the day of delivery the price is to be increased by 1 per cent. for every mark above 80 marks. The following cannot be exported without licence: spare parts for electrical machines (except armatures and collectors), arc lamps and parts of arc lamps (except lamps for cinematographs and carbons), mercury vapour, quartz and similar lamps, complete cases for these lamps combined with glass globes, and electric appliances for heating and cooking.

* * * *

Industrial Training of Overseas Representatives.

Arrangements have been made by which officers of the Departments of Overseas Trade having specialised knowledge of particular trades will pay periodical visits to the more important industrial centres throughout the country. Facilities will be provided by the local Chambers of Commerce to enable the representatives of firms desiring to export British goods to interview the officers of the Department in their own locality. The visits of officers will be made monthly, and extend in each case over a period of about five days. The officers will deal with enquiries connected with overseas trade possibilities and conditions, and as far as may be possible will discuss matters relating to tenders, Overseas demand for particular goods, importers of various goods in Overseas markets, agencies for British manufacturers, &c.

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Rating of Power Motors.

The rating of power motors is being keenly debated at Glasgow at present. At a crowded public meeting last week it was reported that about 2,500 owners of motors were affected, and many had lodged appeals against the proposed rating. Mr. Walker, who presided over the meeting, said there were three questions to be determined: (1) Whether the motors could, under the existing legislation, be rated; (2) whether the present time was opportune; and (3) whether the proposed valuations were equitable. If it was proposed to challenge the legality of rating such motors, he would prefer that three, or a limited number of cases, should be selected, so that if the appellants or the Assessor were dissatisfied with the judgment of the Burgh Appeal Committee, the few selected cases could be taken to the Appeal Court in Edinburgh and a final decision obtained before the preparation of the autumn Valuation Roll. A further meeting will be held to decide upon a course of action.

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Advantages of Electric Heating and Cooking.

There has been much controversy between electrical and gas engineers as to relative advantages of heating and cooking by electricity and gas, but the steady progress in the use of electric appliances seems to show that there are many factors besides the first cost and charges for electricity and gas to be considered. For instance, in the last issue of "The Times" Trade Supplement, a South American correspondent, who signs himself "Parteño," states that for nearly a year he ran both heating and cooking by gas, the gas company granting him a 30 per cent. rebate for everything except lighting, and the cost was by no means high. He changed over to electricity (which for power was a shade under 1d. a unit), not because he thought it would be cheaper, but for the great gain in cleanliness, and also because he was convinced that for cooking it would be far superior to gas, the pressure of which frequently varied and consequently upset cooking calculations. So he made everything electric—water heating, ironing, fires, &c.—and his fuel bill was approximately £2 10s. per year more than before, but he considers that he saved more than 20 times this sum in decreased labour, absence of dirt and smell, and improved condition of house. He winds up by saying: "My chief regret here is that manufacturers seem too busy to attend to export, as I have been vainly trying to get some more apparatus both for myself and some friends."

Nearly all the London and provincial supply companies report a great increase in the connections of radiators, cooking apparatus and other domestic appliances. During the past year the City of London Company sold over 5,000,000 units for heating alone, about one-sixth of the total sales of electrical energy, and the companies supplying in the West End have equally good results to report. A similar story is told by the provincial companies. For instance, the small Harrow Electric Light Company announces that the sales during 1919 included 57 electric radiators, 9 kettles, 5 toasters, 10 boilers and 100 irons.

Electricity Supply.

Cupar Town Council has appointed a committee to consider an electric supply scheme prepared by Mr. Jas. Duncanson.

Tamworth Town Council has suggested to its neighbouring authorities that concerted action should be taken to form a joint electricity board.

For the purpose of carrying out extensions of the electric lighting system of Dublin the Corporation propose to create Stock to produce £68,893.

The borough electrical engineer (Mr. R. F. Ferguson) has submitted to the Corporation a scheme for lighting the well-known Hastings Caves electrically.

It has been decided by Walsall Corporation to lay a main from Bloxwich sub-station to Mid-Cannock Colliery to supply the colliery and other premises at a cost of £30,300.

Wolverhampton Corporation has adopted the proposals of the Electricity Committee for extensions of the supply mains and additional converter plant at an estimated cost of £34,058.

The salary of Mr. J. W. Spark, borough electrical engineer at West Hartlepool, has been increased from £650 to £750, and that of the tramways manager (Mr. C. Burgess) from £450 to £550.

In view of the extra work involved by the large extensions about to be undertaken, Sunderland Council will appoint an additional assistant in the electricity department at £350 per annum.

The rebate to domestic electricity consumers has been fixed by Blackpool Electricity Committee at ¼d. per unit. It dates from Jan. 1, and will continue until the Coal Controller rescinds or revises the coal rebate.

Ashton-under-Lyne Council has decided to apply to the Electricity Commissioners to form a Joint Electricity Authority for the undertakings of Ashton Corporation and of the Stalybridge, Hyde, Mossley and Dukinfield Joint Board.

Leicester City Council is recommended to increase the salary of the electrical engineer of the tramways and engineer and manager of the electricity department (Mr. T. R. Smith) from £1,000 to £1,260 per annum, and the salary of the tramways manager and secretary (Mr. A. F. Lucas) from £600 to £780 a year.

The directors of the Westminster Electric Supply Corporation, Ltd., issued the following notice to their consumers:—The proposed increase of ½d. per lighting unit as from Jan. 1 last (notice of which was given in September, 1919) will not now be made. The rates of charge will therefore be the same as last year.

Wigan Council has increased the salary of the electrical engineer (Mr. Owen) from £650 to £850 per annum with house, fuel and light, with a further increase to £1,000 on April 1, 1921, provided he remains with the Corporation for three years. The demand for electricity is so brisk that cable extensions are urgently required and application has been made for sanction to a loan of £50,000, of which £24,000 is required for Ryland's Mills and £12,000 for the Worsley Mesnes Mill extensions.

The formation of No. 7 District Council of the East Midlands Area Electricity Supply Industry, was decided upon at a meeting held at Nottingham last week under the presidency of Ald. S. Flint of Leicester. Ald. E. Huntsman was appointed chairman, and Mr. W. H. Gilkes, vice-chairman. The representatives of the employers and men were appointed. The employers' secretary is Mr. W. J. Board, Town Clerk, Nottingham (*pro tem.*), and the Trade Unions' secretary, Councillor F. Acton, Derby.

It was announced in the House of Commons last week that the Water Power Resources Committee, of which Sir John Snell, the Chief Electricity Commissioner, is chairman, is drafting its report. When prepared it will be the duty of the Electricity Commissioners to give it consideration. It is stated that the Committee will recommend the setting up of a central authority to be known as the Water Power Development Commission, and that this central authority should have statutory powers to carry out their duties.

The Electric Supply Corporation, Ltd., which is supplying electric current for public and private lighting in Chelmsford is asking for an advance of about 50 per cent. above pre-war rates for the public lighting. The Council is unwilling to concede this demand, and the Corporation gas department is now reported to be entrusted with the street lighting, without any quotation of cost either in respect of the erection of the lamps or the annual maintenance and supply of gas. The town has been lighted by electricity since 1889.

A new scale of charges for electrical energy, prepared by the city electrical energy (Mr. H. Richardson) is under consideration by the Dundee Electricity Committee, and is as follows: Domestic scale, a fixed charge of 2s. per 100 sq. ft. of living room; shops, &c., 5s. per 100 sq. ft.; for power, a graded fixed charge based on the maximum demand, all charges being plus ¾d., plus 15 per cent. per unit of current used. It is estimated that the new charges will benefit householders and occupiers of shops, but there will be little or no change in the case of power consumers.

The South Wales & Monmouthshire Linking-up-Committee have received a communication from Sir John Snell, Chief Electricity Commissioner, suggesting that the committee should consider the whole question of Linking-up electricity works from an engineering standpoint with a view to improving the organisation of the supply of electricity in South Wales. It has, therefore, been decided to promote investigations on the lines suggested. Mr. W. A. Chamen has been elected chairman of the committee in place of Mr. Arthur Ellis, who has acted as chairman since 1916; Mr. J. B. Wurr, borough electrical engineer of Swansea, is vice-chairman; and Mr. L. W. Dixon remains hon. secretary.

Electric Traction.

The salary of Mr. A. R. Dayson, general manager of the Sunderland Corporation Tramways, has been increased from £700 to £850 per annum.

Lanark County Council has decided not to proceed with the proposal for the purchase of the undertaking of the Lanarkshire Tramways Company.

The Dumbarton Burgh & County Tramway Company has decided, owing to increased wages and the growing cost of materials, to apply for a revision of their maximum fares, at present 1d. per mile with a ½d. a mile for workmen.

Burnley Council has referred back a proposal of the Tramways Committee to increase the minimum fare from 1d. to 1½d., while the question of the suggested extra services was referred back in view of the shortage of coal at the electricity works.

Milnrow District Council has been informed by the Lancashire & Yorkshire Railway Company that the question of extending the Electrification of the line from Manchester to Oldham and Shaw onward to Rochdale is being considered.

Mr. Peter Fisher will retire from the position of general manager of the Dundee Corporation tramways department on Aug. 15 next, but will continue to act as consulting engineer for five years. It is proposed to appoint a new manager at £600 per annum.

The Standing Orders Committee of the House of Commons have refused to give a decision on the L.C.C. (Tramways and Improvements) Bill, so that the House will now decide whether the Bill is to proceed. The Middlesex Tramways Bill has been indefinitely adjourned pending a decision on the L.C.C. Bill.

The position as to the Kirkcaldy tramways is as bad as the electricity department. At some parts the concrete foundation of the track is broken and beyond repair, no temporary repair lasting longer than a few weeks. There does not seem to be any alternative but to renew a whole section, for which a double instead of a single line is advised where possible. The cost for a single line renewal would be about £8,000, and for a double line about £15,000. It is said the track will become dangerous for running unless serious steps are taken soon, and the engineer and manager (Mr. Francis) thinks a complete renewal of the two worst portions will be cheaper in the long run.

Telegraph and Telephone Notes.

The Spanish Budget Commission has approved a credit for laying a direct Submarine Cable between Bilbao and Gibraltar.

It is announced that the United States Navy will extend wireless communication to foreign countries, with press rates to American news concerns. The Senate has authorised a navy wireless service with Norway, Germany, Constantinople, the Philippines and Siberia.

According to "The Engineer," as a result of experiments conducted at the Signals Experimental Establishment at Woolwich Common, it has been found to be quite practicable to handle traffic by wireless telegraphy at speeds of 100 words per minute, using the standard Post Office type of Wheatstone transmitter with punched tape for transmission and the standard Wheatstone inker for reception. The first tests of this method were carried out between Woolwich and Bedford in July, 1919, when a speed of 62 words a minute was reached. After other trials a prolonged test was made between Woolwich and Weymouth, using quite moderate power. Perfect records were obtained at the following speeds: 2017 words in thirty minutes; 901 words in eight minutes: 379 words in four minutes.

In reply to questions by Mr. Chadwick as to wireless telegraph apparatus for the Mercantile Marine, Mr. Bridgeman stated in the House of Commons last week that wireless apparatus had been invented which under suitable conditions would respond to certain signals by ringing a bell. The question whether such apparatus could be regarded as a satisfactory substitute for a watcher was under the consideration of the General Post Office and Board of Trade, but it could not in any event replace a certificated wireless operator.

Dr. Macnamara also stated that the Admiralty direction-finding stations, of which there were nine in the United Kingdom, were thrown open to the use of the Mercantile Marine as from June 1 last, and no charge had hitherto been made, but it was proposed to make a nominal charge of 5s. as from the 1st prox. for each bearing asked for and given.

At a Conference of Provincial and Suburban Wireless Societies held recently at the Royal Society of Arts, under the presidency of Sir Charles Bright, F.R.S.E., wireless clubs of the following towns and districts were represented: Burton-on-Trent, Plymouth, Southport, Altrincham, Woolwich, Brighton, Sheffield, Manchester, Stoke-on-Trent, Derby, Glasgow, Bristol, North Middlesex and Peckham.

Sir Charles Bright said the object of the meeting was to discuss the general terms on which affiliation should take place, and as to whether future conferences should take place in London or in the other various different towns from year to year.

Capt. Loring made an official statement, in which he said the Post Office officials were strongly in favour of amalgamation, which would tend to keep amateurs within the limits of their licence. The Post Office proposed to grant transmitting licences on the following terms: A licence of about 10 watts where an amateur could prove that he thoroughly understood the apparatus, that he was conversant with the Morse code, and that his transmitting station was to be used for genuine experimental work, and not merely for communications between other stations in a general way.

Institution Notes.

As already foreshadowed in The Electrician, the summer meeting of the Institution of Electrical Engineers will this year be held from Tuesday, July 13, to Friday, July 16, at Cardiff, with visits to Hereford and Swansea. Further particulars will be announced shortly.

The Committee of the Informal Meeting of the Institution of Electrical Engineers have arranged for an informal social evening to take place at the Albert Tavern, Victoria street, London, on Monday, the 29th inst. A smoking concert will be held and proceedings will open at 7 p.m.

Among the new fellows of the Royal Society of Edinburgh are the following: Mr. Herbert S. Allen, M.A., lecturer in natural philosophy in the University of Edinburgh; Mr. R. S. Bagnall, director of engineering works, Rydal Mount, Blaydon-on-Tyne; Mr. Wm. Gordon, B.Sc., A.M.I.Mech.E., lecturer in engineering in Edinburgh University; Prof. Alex. R. Horne, B.Sc., M.I.Mech.E., A.M.I.C.E., Robert Gordon's Technical College, Aberdeen; Mr. Thomas A. Lindsay, M.A., B.Sc., head science master, Madras College, St. Andrews; and Mr. John B. Todd, B.Sc., lecturer in engineering in the University of Edinburgh.

The London Section of the Igranic Engineering Society recently held an open meeting under the presidency of Mr. Geo. A. Mower, when a Paper was read by Mr. J. T. Mould on "Electric Motor Control Gear." After calling attention to the great development that had occurred within recent years, Mr. Mould said the functions of this gear now extend to the actual supplanting of manual labour and it may nowadays be regarded as the thinking part of the mechanism. In proof of what he acknowledged might appear extravagant claims, Mr. Mould explained the principle and operation of many types of self-acting control gear, both for direct and alternating current, and gave illustrations of their application in various industries.

The following are among the lecture arrangements at the Royal Institution, after Easter: Major G. W. C. Kaye, two lectures on "Recent Advances in X Ray Work"; Major C. E. Inglis, two lectures on "The Evolution of Large Bridge Construction"; Mr. Sidney Skinner, two lectures on (1) "Ebullition and Evaporation", (2) "The Tensile Strength of Liquids"; Prof. W. H. Eccles, two lectures on "The Thermionic Vacuum Tube as Detector, Amplifier and Generator of Electrical Oscillations"; Prof. J. H. Jeans, two lectures on "Recent Revolutions in Physical Science": (1) "Theory of Relativity"; (2) "Theory of Quanta" (the Tyndall Lectures). The Friday Evening Meetings will be resumed on April 16, when Prof. J. A. McClelland will deliver a Discourse on "Ions and Nuclei." Succeeding discourses will probably be given by the Rt. Hon. Lord Rayleigh, Prof. Karl Pearson, Prof. J. A. Fleming, Prof. W. L. Bragg and others.

At last week's meeting of the Institution of Electrical Engineers the President (Mr. Roger T. Smith) said most of the members were anxious about the Civil Engineers' Registration Bill. This had claimed the attention of the Council and of a sub-committee for the last four months. Had the Institution of Civil Engineers proceeded in their original proposal the Council had made arrangements to ascertain the views of the members as a whole, and to act accordningly. The original proposal had been amended, but the Council were continuing to discuss the matter with the Institution of Civil Engineers and other engineering societies, with the object of arriving at a friendly settlement. Such negotiations were necessarily confidential, and they could not yet discuss details. The Council had no hesitation in refusing to accept the solution of the problem put forward by the Civil Engineers as satisfactory, and the Council would oppose any solution that did not seem to them satisfactory. When a satisfactory solution was put forward, as he hoped it might be, all engineers acting together, the Council would consult the members before committing them to it.

At a largely attended meeting of the Institution of Civil Engineers on Tuesday Sir Alex. Kennedy exhibited a series of lantern views of the damaged districts in France and Flanders, chiefly produced from photograph taken by himself. Sir Alexander said it was almost impossible to realise that large tracts of land which were now utterly devastated were formerly covered with houses, gardens, orchards and cultivated fields. In the course of his lecture he pointed out that much of the damage to churches and dwellings was not done unavoidably, but deliberately, out of sheer devilment. The inhabitants did not complain so much of the effects of shells upon their homes, as of the wanton damage done to their furniture and household utensils, which were deliberately smashed or thrown out of the windows. In some cases, too, the Germans were guilty of defilement of which the worst hooligans of any other country would not commit. During Sir Douglas Haig's advance from Amiens to Delville Wood six water gaps including the Somme, had to be crossed. These were bridged by the Royal Engineers in 24 hours. Excellent views were also shown, which gave a vivid idea of difficult operations carried out by the British and Colonial troops, such as the crossing of the St. Quentin Canal, followed by the ascent of a steep bank 60 ft. high. An interesting object shown was a memorial erected by the French in honour of the Highlanders who took the Chateau of Buzancy, after the French and Americans had failed. It bore the inscription "Here will flourish for ever the glorious thistle of Scotland among the roses of France." At Ypres our soldiers withstood attacks for a longer time than at Arras and Verdun. He hoped the tower of the Cathedral which still stood, would be left as a permanent memorial of the heroic thin line of men which prevented the German advance to the Channel Ports. Ypres was as much entitled as Verdun to the proud motto: "On ne passe pas."

Miscellaneous.

The members of the Joint Industrial Council for the Tramways Industry, who have been unable to reach a settlement of the employees' demand for 10s. per week increase, have been referred by Sir R. Horne to the Ministry of Transport, and Sir William Marwood has promised an immediate inquiry into the condition of the tramways industry.

Considerable credit is due to the organisers of the ingenious function which was arranged on Friday last at Slaters Restaurant, Cannon-street, for the entertainment of the B.T.-H. Staff of Mazda House. The organising committee arranged an affair (might one call it a soiree ?) which included a little cards, lasting for rather more than an hour; a little supper of sandwiches, sweets and coffee; and finally a little concert, in which every item was rendered by a member of the B.T. H. staff. Mr. J. N. Stephens distributed the prizes and occupied the Chair during the subsequent concert.

The annual dance of the staff of Greenock Corporation electricity department and friends took place in the Tontine Hotel on 25th ulto. Through the efforts of Mr. W. McGibbon, installation superintendent, the hall was tastefully decorated, a pleasing novelty being introduced by way of four B.T.-H. floodlight projectors fitted with coloured screens. The company included Mr. F. H. Whysall, burgh electrical engineer, and Mrs. Whysall; Bailie Russell, vice-convener of the Electricity Committee, and Mrs. Russell; but the convener of the Electricity Committee (Mr. N. M. Brown) was prevented from being present. Representatives of many leading engineering and manufacturing firms were also present. Mr. Roberts, meter superintendent, was responsible for the excellent arrangements of a very successful social event.

The annual general meeting was held of the Batti-Wallah's Society at the Holborn Restaurant on Monday last, the retiring president, Mr. Hayden T. Harrison, occupying the chair. Mr. Harrison, together with the Committee elected in 1914, carried on during the war. Mr. W. Wyld was elected President by acclamation, Mr. W. E. Ireland, a vice-president, and Mr. F. Pooley and Mr. A. J. Greenly were re-elected Hon. Secretary and Hon. Entertainment Secretary respectively. The new committee comprises Messrs. E. S. Barralet, W. Blake, J. P. McGuinness, R. Wilson Smith, H. Foulds and L. S. Richardson. Batti-Wallah's are reminded that the annual dinner will be held at the Holborn Restaurant on March 26, and tickets may now be obtained from the Hon. Secretary, Broadway, Westminster, London, S.W.

In the Award of the Industrial Court, on the application of the Engineering Trade Union for an advance of 15s. a week to men and 10s. to youths, a new principle is introduced. In December last the men obtained an advance of 5s. a week under an award of the Interim Court of Arbitration, largely on the ground that an increase in prices was expected to take place during the winter. That expectation appears to have been partially fulfilled, the official index number of the cost of living having advanced from 120 above pre-war level in October last to 130 at present. The Court now hold that the men's claim on the ground of the cost of living fails.

The awards of the Committee on Production and Court of Arbitration were given principally on the ground of changes in cost of living. The present decision points out that while during the exceptional circumstances of the war it was proper to take into account the cost of living as the principal determinant of wages, other considerations now arise. The view is held that the remuneration of workpeople should depend on the value of the work done, and that the value of the work done depends on the state of the market. The engineering trade is in a condition of exceptional activity owing to the need for repairing the loss and wastage of war. The rates of the men concerned have, apart from advances to meet the increased cost of living, remained unchanged for several years, and reference is made to the relationship between wages in the engineering industry and those in other trades, and the desirability of stabilising the position in the industry for a reasonable period. Having regard to these various considerations, the Court have decided on an advance of 6s. a week on time rates of men 21 years of age and over, and an advance of 15 per cent. on piecework prices. Half the advance becomes due on April 1 and the remaining half on June 1. The advances are payable to all workers, irrespective of age, so far as they are employed on piecework, and also to labourers under 21 years of age who are customarily paid men's rates.

Personal and Appointments.

The Marquis of Crewe has been elected President of the Association of Technical Institutions in succession to Lord Sydenham.

The Senate of Dublin University has conferred the degree of D.Sc. on Prof. W. H. Bragg, F.R.S., of the University of London, and Prof. R. A. Millikan, of the University of Chicago.

The University of Aberdeen has decided to confer the honorary degree of LL.D. on Sir J. C. Bose, founder of the Bose Research Institute, Calcutta, and on Mr. J. H. Jeans, secretary of the Royal Society.

Mr. E. M. Hughman has left for Bombay in the P. & O. liner "Margha," accompanied by Mrs. and Miss Hughman. He has been in England for a few months' visit, and he is returning to superintend his firm's Government contracts.

Glasgow Electricity Committee recommend the promotion of Mr. Robert B. Mitchell, assistant Manager and Engineer, to the position of general manager and engineer of the electricity department in succession to Mr. W. W. Lackie, who was recently appointed a member of the Commission on Electrical Supply. Mr. Mitchell has been 22 years with the Corporation.

Tenders Invited and Accepted.

Bacup Corporation require tenders by noon March 27 for one year's electricity supplies. Forms of tender from the Electrical Engineer.

Dunedin (N.Z.) Council require tenders by April 26 for electric car bodies, car trucks and equipment. Specifications from the Town Clerk.

Bedford Corporation electricity department invite tenders for year's supply of meters and cables. Tenders to Town Clerk by noon, April 3.

Dublin Guardians want tenders by noon March 24 for six or 12 months' supply of electric fittings, &c. Forms of tender, &c., from the Master of the Workhouse.

Leith Corporation want tenders by April 13 for one year's supply of overhead, electrical and car fittings, insulated wire, &c. Schedules, &c. from the Burgh Surveyor.

Toxteth Park guardians require tenders by March 24 for three months electrical and engineers' supplies, &c. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

West Ham guardians require tenders by March 25 for six months' supply of electrical fittings, ironmongery, &c. Forms of tender from the Clerk, Union-road, Leytonstone, London, E.11.

Rhondda Council want tenders by noon March 31 for one year's supply of a.c. meters, cable joint boxes, compound, cut-outs, &c. Specifications, &c., from the Engineer, Electricity Works, Porth, Glam.

Newport (Mon.) Corporation require tenders by 10 a.m., March 27 for (1) tramcar bodies, (2) tracks, and (3) electrical equipment. Forms of tender, &c., from the Borough Electrical and Tramways Engineer.

St. Annes-on-Sea Urban Council require tenders (by 29th inst.) for three-core paper-insulated lead-covered and armoured pilot cable, stoneware troughing and covers. Particulars from the engineer, Mr. J. H. Clothier.

The Lancashire & Yorkshire Railway Company require tenders by 10 a.m. March 22 for 12 months' supply of signal, telegraph and electric fittings, and signal, telegraph and electric light wires, &c. Particulars from the Stores Superintendent, Osborne-street, Manchester.

The City of Melbourne invites tenders for the supply of 12,000 metal filament lamps. Specifications from the agents of the City Council, Messrs. McIlwraith, McEacharn & Company Pty., Ltd., Billiter-square-buildings, London, E.C. 3, to whom tenders by noon March 30.

The Secretary to the Tender Board, Public Works Department, Wellington, N.Z., will receive tenders until noon, June 30, for electrical equipment for the Arthur's Pass Section of the Midland Railway. Specifications from the Head Office of the Department, Wellington, N.Z.

Oudtshoorn (Cape Province) Municipality require tenders by April 24 for supply of a loco. type steam set with generator and switchboard, or, alternatively, (*a*) boiler and auxiliaries, (*b*) steam set with generator, (*c*) condenser and auxiliaries, and (*d*) switchboard. Specification from the Municipal Electrical Engineer.

Tenders are invited for the supply and delivery in Melbourne of two 2,000-kw. rotary converters and h.-t. and d.-c. switchgear. Specifications from the Agents of the City Council Messrs. McIlwraith, McEacharn & Company Proprietary, Ltd., Billiter-square-buildings, London, E.C. 3. Tenders to the Town Clerk, Melbourne, by April 12.

Heywood Electricity Committee has accepted the tender of the Macintosh Cable Company for a further supply of e.h.t. cables.

Sunderland Corporation has accepted the tender of the British Insulated & Helsby Cables, Ltd., for insulating tape; and that of Ferguson, Palin, Ltd., for switchgear.

Middlesbro' Corporation has accepted the following tenders:—British Insulated and Helsby Cables, three miles h.t. cable, £6,370, and 720 yards of ·4 × ·4 × ·15 sq. inch cable, £1,248; Metropolitan Vickers Electrical Company, seven 150 k.v.a. single-phase transformers, £2,030, and twelve 3,000 volt switches, £1,470.

Great Yarmouth Corporation invite tenders for supply and erection of one 2,000 kw. turbo-alternator, one 750 kw. rotary converter and transformer, and one 750 kw. frequency changer. Specifications from the consulting engineers (Messrs. Preece, Cardew & Rider), 8, Queen Anne's Gate, London, S.W.1, and may be seen at the office of the Corporation electrical engineer, Mr. Gordon Bryant. Tenders to the Town Clerk by 11 a.m. April 16.

Educational.

In order to provide more accommodation at the Cavendish Laboratory at Cambridge University it is proposed to proceed with the building of a second storey over the large laboratory.

Glasgow University has accepted an offer of £5,000 to establish a lectureship in electrical diagnosis and therapeutics at the Western Infirmary. In regard to the foundation of the new Cargill Chair of Applied Physics, the draft ordinance has been approved and the Faculty of Science have expressed their appreciation of the gift which made such a valuable addition to the scientific resources of the University.

The Ramsay Memorial Fund Committee have allotted £25,000 towards the erection of a Ramsay Memorial Laboratory of Chemical Engineering, but £50,000 is needed for building and equipment, and £25,000 is needed as an endowment fund. The Committee, who have decided to close the general fund in June, are making a final appeal for contributions, which should be sent to the hon. treasurers, Lord Glenconner and Prof. J. Norman Collie, at University College, Gower-street, London, W.C.

Business Items, &c.

Erith's Engineering Company, Ltd., have now removed to 83, Kingsway, London, W.C.2, and the telephone number is Gerrard 1106.

Thomas Hall and Jas. N. Johnson (trading as James Nelson Johnson & Company), electricians, 25, Porter-street and 68a, Wright-street, Hull, have dissolved partnership. Debts by Mr. Hall.

Messrs. Matthews & Yates, Ltd., have published a new booklet on their patent system of humidification, heating, cooling and ventilating for textile factories, &c. The system is independent of the main drive.

Arthur L. Furneaux and Arthur G. Thomas (trading as Furneaux & Thomas), electrical engineers and contractors, Swansea, have dissolved partnership. Debts by Mr. Thomas, who continues the business.

Alex. Geo. Smith and Joseph Smith (trading as A. G. and J. Smith), electrical engineers, 122, Titchfield-street, Kilmarnock, have dissolved partnership. Debts by Mr. A. G. Smith, who continues the business under his own name.

Hy. W. Johnson and John O'Sullivan (trading as Johnson, O'Sullivan & Company), electrical engineers, 5, Manor-parade, Church End, Finchley, London, N., have dissolved partnership. Debts by Mr. Johnson, who continues under the present style.

Mr. Fred S. Lee, Importer of Electrical Appliances, of 38, Market-street, Sydney, Australia, has arrived here by way of Japan and America. Mr. Lee, who (is representing Messrs. Dorman & Smith in Australia), invites correspondence to his temporary office at 59, Mark-lane, London, E.C.3, from electrical manufacturers desirous of disposing of their products in the Commonwealth of Australia and New Zealand.

Sir J. F. Payne Gallwey, Brown & Company, Ltd., is the title of a new company, with a capital of £50,000, which has acquired the interests of Messrs. Payne Gallwey, Brown & Company, formerly trading at 49, Queen Victoria-street, E.C.4. The offices of the new company are at 58, Victoria-street, S.W.1. The joint managing directors are Sir J. F. Payne Gallwey and Mr. C. L. Brown, A.M.I.E.E. The company carries on the business of a central organisation for the distribution of machinery, equipment and stores for collieries and works, exporters and importers. The company has a staff of expert engineers, and has facilities for carrying out complete equipment of collieries and works. Separate departments deal with the supply of materials and the expert technical supervision of work carried out. From its inception the company has expanded to such an extent that it has been found necessary to open branch offices in the principal coal centres.

Mr. R. E. Winkfield, M.I.E.E., after 15 years has just returned from India, where he held the position of agent and chief engineer to the Calcutta Electric Supply Corporation, and he has been appointed general adviser to the board. Mr. Winkfield has now associated himself with the Robertson-Cole Company of 5, Bishopsgate, London (and New York), which firm, in conjunction with Messrs. Graham & Compnay, of Calcutta and Bombay, have established a large connection with the mills and factories throughout India and the East, by acting as buying and shipping agents in the United Kingdom and America. Mr. Winkfield's long experience of oriental engineering requirements will enable him to be of assistance to those wishing to purchase machinery for India and the East. Before going to India he was for seven years with the Metropolitan Electric Supply Company. Later he joined the British Thomson-Houston Company, and was for some years engaged in the electric construction work of the Central London Railway; thereafter he became resident engineer on the Great Northern & City Railway, until he left England for the East.

Liquidations.

Ebonitis, Ltd., is being wound up voluntarily, and Mr. E. C. Moore, 3, Crosby-sq., London, E.C.3, has been appointed liquidator.

A meeting of creditors of the Trafford Power and Light Supply (1902), Ltd., will be held at 60-62, Spring-gardens, Manchester, on March 26.

A first and final dividend of 20s. is payable at 33, Carey-street, London, W.C.2, to non-enemy creditors of the Electrical Company, Ltd., and the A.E.G. Electrical Company of South Africa, Ltd.

A meeting of creditors of the Telephos Domestic & Street Lighting Company, Ltd., will be held at Room 805, Salisbury House, London, E.C., on March 25. Claims are to be sent to Mr. H. H. Foster, 805/9, Salisbury House, by April 30.

At a meeting of creditors of F. Husband, Ltd., electrical engineers, of Craven House, Kingsway, London, W.C., last week, it was stated by the Liquidator (Mr. R. S. Farries) that the total capital put into the concern was £2,257. No shares having been allotted, the amounts put into the business appeared as advances, but it was always intended that the money should be for shares. The whole of the £2,257 had been lost, and the company had two bank overdrafts amounting to £1,697. The assets were estimated to realise £3,133, including £81 which had to be deducted for preferential claims, and the remaining £3,052 was subject to the claims of debenture holders, £2,428. Liabilities to creditors aggregated £3,346. Owing to the liquidation the licence of the company to manufacture and sell the "Husband" fire had terminated, so he did not think there could be much value in the goodwill. Several creditors expressed dissatisfaction at the position disclosed, and it was resolved to apply to the Court for the appointment of Mr. W. Osborne (Messrs. Corfield & Cripswell) as liquidator, and a committee of inspection was nominated, consisting of Mr. J. Scriven (Z. Electrical Company), Mr. E. Heath (Heath, Wingfield & Company) and a representative of the General Electric Company.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & CO., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 SPECIFICATIONS.

136,497 SIEMENS BROS. & CO., PET[illegible]RY & SUMNER. Selecting devices for automatic telephone systems. (14/7/19.)
136,500 WINNE. Electric furnace control apparatus. (2/1/19.)
136,511 HAUSDORF. Telephone receivers. (9/9/19.)
136,515 FERRANTI, DE WALL & FERRANTI, LTD. Measurement of alternating electric current power. (21/12/18.) (Divided Application on 21,466/18.)

Relates to a two-element meter for the measurement of the wattless component of electric energy in a single-phase circuit, having different relative shunt flux lags and giving equal and opposite torques on a non-inductive load.

136,516 CABLE ACCESSORIES CO., REEVES & CRAWFORD. Electrical fuses. (12/12/18.) (Divided Application on 20,686/18.)
136,539 HAGGAS & HAGGAS. Electric motor drives for planing machines and the like. (16/1/18.)
136,679 HARVEY. Electrically-heated melting furnaces. (9/1/19.)
136,683 SMITH. Magnetos for ignition purposes. (17/1/19.)
136,691 LESSELLS. Electric cable carrying or supporting means. (25/1/19.)
136,694 ROSS. Anti-vibration electric light fittings. (31/1/19.) (Addition to 122,707).
136,696 MARKS. (Splitdorf Electrical Co.) Ignition-magneto generating devices. (31/1/19.)
136,705 CONNER & PUCKETTE. Magneto-electric machines for internal-combustion engines. (10/2/19.)
136,712 WESTERN ELECTRIC CO. Transmission system for transmitting high-frequency electric currents. (19/2/19.)
136,720 MEACHER. Method of electrically welding platinum or other metal discs to the ends or heads of metal screws or rods. (25/2/19.)
136,722 MIDGLEY & VANDERVELL & CO. Induction coils. (26/2/19.)
136,762 PEDERSEN. Arc generators of electric oscillations. (4/3/19.)
136,791 BURDON. Telephonic arrangement for use by firemen. (15/9/19.)
136,960 WATSON & CO., GREAVES ETCHELLS & TRAVIS. Electric furnaces. (21/2/19.)
136,967 COLLINS, COLLINS & PITCHER. Connectors for use with electrically operated or heated devices. (3/3/19.)
136,998 PERRER. Electrical resistances. (8/5/19.)
137,002 AMES. Electrical generators. (29/5/19.)
137,003 AMES & GILLINSON. Electrical condensers. (29/5/19.)
137,012 LAUTH. Electric cooking or heating apparatus. (23/12/18.) (Divided Application on 21,547/18.)
137,018 SIEMENS BROS. & CO., CHRISTIAN & SUMNER. Selecting devices for automatic and telephone systems. (14/7/19.)
137,367 COHEN. Telephone circuits. (9/1/19.)
137,390 AUTOMATIC TELEPHONE MFG. CO. & BATES. Automatic telephone systems. (24/1/19.)
137,410 THORNE. Electrical switches. (20/2/19.)
137,417 ODIERNO. Trolley for electric tramways. (27/2/19.)
137,418 MARSH. Electrical push switches for mines or other gaseous places. (28/2/19.)
137,433 GARDNER. Electric signalling controlled by mechanical vibrations. (22/3/19.)
137,437 TIDSWELL & KIRKLAND. Trolley heads for electric tramcars and other vehicles. (28/3/19.)
137,477 MACROPOULOS. Rotary rectifier of alternating current. (12/6/19.)

The rectifier comprises a rotary shaft, three brushes connected for the positive impulses, three brushes connected for the negative impulses, corresponding contact segments mounted to rotate with the shaft, and a collector ring in electrical connection with each group, positive and negative, of the contact segments, in which the contact segments and collector ring of each group are insulated from the contact segments and collector ring of the other group, and the contact segments of each group for contact with the brushes of that group are arranged to follow one another in the relation of the several phases of the current.

137,489 RAILING, GERRARD & WILSON. Electric cut-outs. (26/2/19.)
137,590 CONRAD. Electric fuse cartridges. (13/1/19.)
137,591 CONRAD. Electric fuse supporting plugs. (13/1/19.)
137,592 MELAUN. Electric light sockets. (13/1/19.)
137,600 SADLER. Cases or containers for electric lamp bulbs. (2[illegible]/1/19.)
137,609 MATHESON & KAELIN. Electrolytic cells. (23/1/19.)
137,612 TATE & MONKHOUSE. Automatic cut-outs and substitutional resistances. (24/1/19.)
137,622 DINGLEY & MAJOR. Contact-breakers for magnetos. (30/1/19.) (Cognate application 15,972/19.)

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

November 1.

26,859 MCLAUGHLIN. Contact makers for magnetos.
26,873 TAYLOR. Electrical distribution with alternating current systems.
26,887 BROWN & PEARSON. Dynamos, motors, &c.

November 3, 1919.

26,935 TURNOCK. Electrical resistances.
26,980 CAUGHREAN. Incandescent lights.
26,990 DAVENPORT & CO. & WHITE. Electric ignition.
27,006 COBBOLD. Thermionic and other ionic tubes.
27,026 MARTIN & SHARP. Trolley heads for tramcars.
27,040 ST. GEORGE MOORE & WHITMORE. Supporting antennæ used in wireless telegraphy.

November 4, 1919.

27,082 JOICE. Electromagnetic ratchet movement.
27,083 JOICE. Distant control for electric supply systems.
27,085, 27,086 EDISON SWAN ELECTRIC CO. & WRIGHTON. Electric bells.
27,097 COOPER. Locking holder for electric lamps.
27,099 WHITE. High-speed electric signalling.
27,115 DEUTSCHE-MASCHINENFABRIK A.G. Convertor plant. (13/3/19, Germany.)
27,123 MALATESTA. Incandescent lamps.
27,134 DUNH. Obtaining electrical energy from the atmosphere.
27,143 RUSSELL. Electric power generating units.
27,150 BOORNE. Machine for coating and winding electrodes.
27,151 B. T.-H. CO. (G. E. Co.) Electric resistance units.

November 5, 1919.

27,194 ECCLES. Telegraphic, &c., circuits for use with ionic tubes or valves.
27,195 ANGOLD & RAILING. Portable accumulators.
27,196 RODDES. Electric heat-producing element.
27,222 METROPOLITAN VICKERS ELECTRICAL CO. & AYRES. A.C. motors.
27,226 TWEEDIE. Portable electric lamps.
27,231 HUNTSWORTH. Electrical indicator.
27,256 AYRE-CARR. Hygienic device for use with telephones.

November 6, 1919.

27,314 SCOTT-TAGGERT. Vacuum tubes for wireless communication, &c.
27,324 ELECTROMOTORS, LTD., GREENHALGH & LONGBOTTOM. Electric driving, &c., of planing machines.
27,340 BAKER & PARSONS. Switches.
27,342 ALAVOINE. Electrical heat pads.
27,346 MIDLAND ELECTRICAL MFG. CO. & BAKBER. Ironclad switches.
27,376 BURDON. (Siemens Schuckertwerke.) Arc lamps or projectors and carbons therefor.

Companies' Reports, &c.

LONDON SUPPLY COMPANIES.

The profit of the BROMPTON AND KENSINGTON ELECTRICITY SUPPLY COMPANY, LTD., for 1919 was £29,362, and with balance (£2,276) brought forward, interest, &c., makes a total of £32,918. After deducting £1,631 for the interim dividend on the 7 per cent. cumulative preference shares, and £5,969 interim dividend at rate of 7 per cent. per annum for the half-year on the ordinary shares, the directors recommend that the balance (£25,948) be dealt with by writing £181 off cost of investments, placing £8,000 to reserve, paying the dividend on the preference shares for half-year ended Dec. 31 (£61,018) and a dividend on the ordinary shares for the half-year ended December at the rate of 17 per cent. per annum, making 12 per cent. for year (£14,519), paying £1,000 as directors' additional remuneration, and carrying forward £1,230. There are 7,389 consumers (against 7,013) and the equivalent of 433,152 35 watt lamps is connected, an increase of 30,470.

Mr. A. W. Tait, C.B.E., who presided over the meeting of the METROPOLITAN ELECTRIC SUPPLY COMPANY last week said the increase in revenue was largely due to the extension of the lighting load during the last quarter of 1919, when all lighting restrictions were removed. A satisfactory feature had been the number of new consumers connected, representing 2,867 kw. There was every evidence that the demand for electricity for all purposes was broadening out considerably. The costs of generation and distribution showed an increase of £29,000, of which about £14,000 was accounted for by the increased cost of coal, notwithstanding the decrease in the number of units generated and the consequent diminished consumption. The increase in wages and salaries accounted for £9,700, and the wages for the current year would be still further increased by a sum representing an additional war allowance of 5s. per week, which was granted in January last. Substantial increases in the war allowances had also been granted to the staff to meet the increased cost of living. The capital expenditure was £53,805, against £25,267 in the previous year. This item would show a substantial increase over the next few years if they were to provide adequately for the demand of the consumers already connected and those who were likely to come on to their system in the near future. The progress of the Uxbridge Company was quite satisfactory. The increase in load in the metropolitan area, not only in London and Paddington, but also in the western area, would shortly necessitate installing further plant in the Willesden station and the laying of additional feeders, particularly in the western area. The directors recommended a final dividend at rate of 10 per cent. per annum, making a total distribution for the year of 6 per cent., absorbing £50,000, leaving £4,440 to be carried forward. The directors were pleased again to be able to recommend an increase in the dividend, accompanied as it was by a substantial increase in the amount carried to depreciation and reserve fund. The progress made since the close of the year supported the opinion that they would be able to continue the increased dividend.

Addressing the shareholders of the CHARING CROSS, WEST END & CITY ELECTRICITY COMPANY, LTD., at the meeting on Thursday last, the chairman (Mr. W. F. Fladgate) stated that the outstanding feature of the past year was the increase in the units sold and the consequent increase in gross revenue. In the City area their output was nearly 2,000,000 units more than in 1911, the previous record year. In the West-end area the output was the highest of any preceding year except 1913, and had the sale of current for public lighting been normal the output for even that year would have been exceeded. While that increase was satisfactory, the strain put upon their resources had only been met by the most careful work at their stations, and much praise was due to their staff. In 1918 and last year they did some of the repairs which during the war it was practically impossible to do. They also ordered new plant, but delays had occurred. A large turbine which should have been in position in November would not be delivered until June next. Costs have again increased, the main cause being the cost of labour and the price of coal. Increases sanctioned made the war bonus payable to all employees no less than 33s. 6d. per week, and a further award, increasing the wages of some engineers, was made in February last. With regard to the delivery of coal, they and all other electrical lighting companies felt that they had not been treated fairly by the authorities. They had been practically obliged to take whatever was delivered at the price which was fixed, and in many cases what has been delivered was little more than rubbish. In 1914 their coal bill did not amount to £40,000; in 1918 it came to £108,000, and last year to £157,000. However, receipts had largely increased; those in the West-end by some £70,000 and in the City by nearly £100,000. Their maximum price in the City was fixed after the maximum price which was fixed for their competing company, and while that company was allowed to go up to a maximum considerably exceeding theirs, they had been prevented by the authorities from increasing their maximum beyond the very moderate one which existed, and one which did not in any way correspond with the increased expenditure of producing energy. After analysing the figures, he said they were paying a final dividend of 5s. per share, making 7 per cent. for the whole year; £10,000 was to be put to general reserve and £8,000 be carried forward. In the City their available total was £66,676, out of which they provided for the interest on debenture stock, loans and advances; and after paying the dividend on the preference shares, £10,000 was to be transferred to general reserve and £7,217 10s. 7d. carried forward. Much had been spent upon repairs at Bow station, but a considerable amount of capital expenditure would be required to enable the company to meet the calls upon its resources.

In moving the adoption of the report of the County of London Electric Supply Company, Ltd., at the meeting on Monday, the chairman (Sir Ernest V. Hiley, K.B.E.) said that he was in the fortunate position of being able to announce satisfactory progress in every direction. The net results were that £50,000 was being placed to reserve for depreciation; they were creating for the first time a general reserve account, and placing thereto £45,000 out of revenue; preliminary expenses had been written down out of revenue by £5,000; an increased dividend of 1 per cent. was to be paid on the ordinary shares, making 8 per cent. (instead of 7 per cent.) for the year, while £19,188 was being carried forward against £15,515 brought into the accounts. Receipts from sale of current and meter rentals amounted to £543,284, an increase of 29 per cent. The gross receipts (£576,116) showed an increase of 27 per cent. The total working costs were £358,642, an increase of £86,261, so that about 70 per cent. of their increased revenue had been swallowed up in increased costs. The items of coal, salaries, wages and repairs accounted for £71,598 of the increase, while rates, taxes and insurance accounted for £8,260. They were carrying to credit of net revenue account £217,473, against £179,430, which, with the amount brought forward, made £232,989. Those results, having regard to the abnormal conditions and difficulties, must be regarded as very satisfactory, particularly as the lighting restrictions were not removed until towards the close of 1919. Owing to the rapid growth of the business the capital expenditure for the current year must necessarily be heavy, as they were increasing the capacity of their Wandsworth station to enable them to deal with the greatly increased demand. Practically the whole of the capital expenditure (£130,043) during the year was provided out of revenue; and although the balance shown as reserve for depreciation was £202,025, they had written off from time to time out of that account, in respect of plant scrapped, a sum of £210,564, thus making a total of £412,589 provided for depreciation. The associated companies continued to make satisfactory progress and the South London and Bournemouth companies were both paying dividends increased by 1 per cent. The commercial and general progress was in every way satisfactory. The applications for new business showed an increase of 8,532 kw., and the sale of units had increased by 2,161,409, while the demand on the stations was 7,100 kw. over last year, and the number of consumers had increased by nearly 3,000. Their bulk supply business also showed considerable expansion. The time had now come when they must proceed with the long-delayed programme of development at Barking which had been held up during the war. The figures he had given for the past year constituted a record in the company's history in several respects. It was gratifying to know that the progress shown since the close of the year was even more marked. There was an increase of 23 per cent. in the kilowatts of new business and an increase of 22 per cent. in the units sent out. The company had now reached a stage in its history when an increased margin of profit on the capital invested might be anticipated.

During 1919 the capital expenditure of the City of London Electric Lighting Company, Ltd., amounted to £28,466, but £36,590 was written off buildings, plant, &c., leaving the net expenditure £1,999,772, a net deduction of £8,124.

The revenue for the year was £521,116 and with interest on investments, &c. (£5,756), the total was £526,872. Deducting expenses of generation and distribution (£213,394), repairs and maintenance of buildings, machinery, &c. (£21,327), street lighting expenses (£8,672), rent, rates, &c. (£97,730), leaving £185,748, and with £20,019 from 1918, the total available is £205,767. After providing for interest on loans from bankers and on first and second debenture stock (£23,863), contributing £2,082 10s. to employees' provident and benevolent funds and under National Insurance Act, £3,600 as special contribution to benevolent fund, writing £10,000 off cost of investments and transferring £62,130 to reserve, leaving available £104,092. The directors recommend payment of a dividend of 12s. per share on the preference shares (at the full rate of 6 per cent. per annum) and 20s. per share on the ordinary shares (at rate of 10 per cent. per annum). On account of these dividends 6s. per share on both classes of shares was paid in September, leaving 6s. per share on the preference and 14s. on the ordinary shares (less tax) to be paid. In addition, a bonus of 6s. per share will be paid on the ordinary shares, on account of reduction of dividends for the years 1914 and 1915, leaving to be carried forward £23,050.

The directors regard the result as very satisfactory and are pleased to be in a position, not only to revert to the pre-war rate of dividend for the past year, but also to make good to some extent the loss in dividends suffered by the shareholders during the war. They have also been able to give substantial benefits by the reduction of charges to the Company's consumers dating from September last. This reduction is in addition to any further benefit which certain consumers may receive in due course from the rebate of 10s. per ton on coal used for domestic purposes. The average price of private supply was 3·81d. per unit, against 3·27d. in 1918. The number of units generated was 38,774,187 (against 31,731,491) and sold 31,256,348 (26,656,655), and the total maximum supply demanded 25,410 kw. (against 18,900 kw.). The total units sold for power purposes were 12,092,541 and for heating 5,070,399, a total of 17,162,940 units, or 56·76 per cent. of the total units sold for private supply. The provision of adequate supplies of coal has caused considerable anxiety. Notwithstanding very irregular deliveries and sadly inferior qualities only obtainable, the supply has been maintained without interruption, for which great credit is due to the engineering staff. In 1902 a superannuation fund for the benefit of the staff was established. In 1913 this was converted into a staff provident fund and the opportunity was taken to establish a benevolent fund to which the Company makes annual contributions and out of which the Board is authorised to make grants in all cases where sympathetic assistance is recommended. A voluntary deposit system has now been devised under which employees may place their savings on deposit with the Company, and allow them to accumulate at compound interest. In the belief that the Government cannot seriously desire to prevent the provision of an ample supply of electricity, and will not penalise those who endeavour to meet the growing demands of the community, the directors had arranged, before the passing of the Electricity Supply Act, for the erection of three large power units at Bankside station, together with the necessary converting sub-stations. This plant will be available for the supply of electricity in bulk as well as for the Company's own needs. To meet the expenditure involved it is proposed to increase the nominal capital of the Company to £2,000,000.

The directors of W. T. Henley's Telegraph Works Company, Ltd., recommend a final dividend on the ordinary shares of 2s. 6d. per share (less tax), making, with the interim dividend of 6d. per share paid on Sept. 1 last, 3s. per share for the year.

The Eastern Telegraph Company, Ltd., is offering at par 1,000,000 shares of £1 each to shareholders in the proportion of one new share for every £4 ordinary stock held on March 3. A dividend of 4 4-5d. per share (tax free) will be paid about May 14, 1921, in respect of the period ending Dec. 31, 1920. The shares will be converted into stock as soon as possible after May 14, 1921.

The Eastern Extension, Australasia & China Telegraph Company is offering at par 100,000 shares of £10 each to shareholders in the proportion of one new share for every three held on March 3. A dividend of 4s. per share, tax free, will be paid on May 14, 1921, on the new shares.

An issue of 60,376 ordinary shares of £10 each at par is offered to shareholders of the Glore Telegraph & Trust Company in the proportion of one new ordinary share for every three held on March 3. A payment of 4s. 8d. per share (at rate of 10 per cent. per annum) will be made on or about March 23, 1921.

The Western Telegraph Company, Ltd., is offering [illegible] shares of £10 each at par to shareholders in the proportion of one new share for every two held on March 3. A dividend of 4s. per share, tax free, will be paid on March 23, 1921, on the new shares.

At an extraordinry general meeting of the British Electric Transformer Company, Ltd., last week new articles of association were adopted. Mr. A. F. Berry, who presided, explained that the existing articles were 12 years old and somewhat out of date. The shareholders would be given an opportunity of visiting the works, of seeing the extensions made since the Armistice and the progress that was being made with the new works.

The report of Bruce Peebles & Company, Ltd., for 1919 states that the profit, including interest on investments and transfer fees, and after deducting administration expenses, amount, required for debenture service, &c., amounts to £47,179, which with £3,574 brought forward makes £50,753. There has been applied to depreciation reserve £8,000 and to general reserve £20,000, and the directors recommend a dividend on the ordinary shares for the year at 7½ per cent. per annum carrying forward £5,462. The works have been fully employed during the year and an extension has been made to the new shop for heavy engineering work. Prospects for the current year are encouraging.

The fifty-sixth ordinary general meeting of the Telegraph Construction & Maintenance Company, Ltd., was held on the 11th inst., the Earl of Selbourne, K.G., chairman of the company, presiding. In moving the adoption of the report and accounts and that a dividend of 18s. per share (in addition to the 6s. per share paid to June 30, 1919) be paid, the chairman explained that in the balance sheet the debentures disappeared and the shares were doubled. After an analysis of the year's accounts he said that the amount of working capital required for carrying on a manufacturing business such as their's, was quite doubled what it was before the war. They were fortunate in being able to use their reserves for providing that money. Last year their output was not so great as their annual output often was in the years before the war, but they paid away more than three times as much in wages as in the year before the war. Their turnover during the year 1919 was large, and their profits had been above the average of the last five years, but the enhanced prices of materials compelled them to lock up a much larger sum of money than in past years, in order that the stocks necessary for carrying on the work may be maintained. Their factories continued to be full of work, and they were constantly pressing on the limits of possible supplies of materials, particularly of copper and steel. They were exporting a fair proportion of their output to America.

Throughout the war and since, submarine cables had played a very important part. It was not possible to conjecture even how the war could have been carried on without cable communication. It fell to England's lot to maintain that great system, and even to lay many new cables during the war, and they had their share of those perilous and notable performances, but in consequence of the suspension of general renewals during those five years there was now a world shortage of cable, and the necessity of increased production was very urgent. It might safely be said that there was no cable now working that was not carrying a greater traffic than it had ever carried before, and the cable systems were working very efficiently, but telegraphic communication had increased immensely and more lines were required. There was a general demand for higher wages and an improved standard of living, and labour was working shorter hours. Those good things could only be maintained by all doing their best and taking trouble to increase production.

New Companies.

A. B. C. MANUFACTURING COMPANY, LTD. (10,993).—Private company. Reg. in Edinburgh Feb. 26, capital £5,000 in £1 shares, to carry on the business of electrical, mechanical and motor engineers, founders, &c. First directors are J. Anderson, A. M. Anderson, J. J. Christoe, and J. W. Lynhurst. Reg. office: 11, Douglas-street, Glasgow.

B. E. MANUFACTURING COMPANY, LTD (164,272).—Private company. Reg. March 5, capital £10,000 in 9,950 ordinary shares of £1 each and 1,000 deferred shares of 1s. each. To enter into contracts as manufacturers for and on behalf of the B. E. Company (of London and Birmingham), Ltd. for the appointment of the last named company as sole selling agents for the products of this company, to carry on business as designers, manufacturers, exporters and importers of and dealers in electrical apparatus, burglar alarms, &c. Managing director: C. D. Falcke. Secretary: C. White. Reg. office: Hendon House, 57, Upper Thames-street, E.C.

BOURNE END & DISTRICT ELECTRICITY CORPORATION, LTD. (164,689)—Private company. Reg. March 2, capital £50,000 in £1 shares, to take over the business of the Bourne End Electric Installation Company, and the business of a supplier of electric energy lately carried on at Bourne End by T. G. Lunnon, &c. First directors are R. S. Taylor, E. W. Lean and H. S. Dennington.

CAMPION, BALL & COMPANY, LTD. (164,342)—Private company Reg. Feb. 21, capital £2,000 in £1 shares, to take over business carried on at Regent-terrace, West-street, Sheffield, as Campion, Ball & Company, and to carry on the business of electrical engineers, &c.

DICKINSON & THOMPSON, LTD. (164,527.)—Private company: reg. Feb. 26, capital £2,000 in £1 shares (1,000 8 per cent. cumulative preference), to carry on the business of electrical engineers, founders, &c. First directors are R. G. Thompson, W. Dickinson, D. L. M. Thompson and N. F. Thompson. Reg. office, 51-52, Chancery Lane, W.C.

DODDS, FINLAY & COMPANY, LTD (10,982).—Private company. Reg. in Edinburgh Feb. 21, capital £5,000 in £1 shares, to carry on the business of electrical and mechanical engineers, machinists, &c. First directors are T. S. Dodds, R. M. Finlay, J. Dodds and G. S. Dodds. Reg. office: East End Engineering Works, Fauldhouse.

EDMISTON, BROWN & COMPANY, LTD (10,988)—Private company. Reg. in Edinburgh Feb. 24, capital £30,000 in £1 shares (25,000 5 per cent. cumulative preference), to acquire the business of Edmiston, Brown & Company, mechanical and electrical engineers, merchants and agents. First directors are A. A. Edmiston, G. J. L. Brown, C. E. Hart and G. T. McGlashan. Reg. office: 219, St. Vincent-street, Glasgow.

STANDARD ELECTRIC WELDING COMPANY, LTD. (164,324) Private company. Reg. Feb. 20, capital £5,000 in 10s. shares, to carry on the business indicated by the title, and to adopt an agreement with the Shipbuilding & Engineering Appliances Company. First directors are J. D. Andrew, W. J. Pickersgill, T. H. Pattinson, T. W. Crozier and J. H. Readhead. Reg. office: 31, Grainger-street, West Newcastle-on-Tyne.

UNIVERSAL MOTOR INDUSTRIES, LTD. (164,370) Reg. Feb. 21, capital £1,250,000 in 1,150,000 shares of £1 each and 1,000,000 shares of 2s. each. Objects: To carry on the business of manufacturers of and dealers in motor cars, wagons, vehicles, engines, &c. First directors are H. Pyrah, G. T. Taylor, W. Cass, W. Andrews and R. Radcliffe. Reg. office: Premier House, 150, Southampton-row, W.C.

Prices of Metals, Chemicals, &c.

Tuesday, March 16.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£116 0 0	—	£6 0 0
Electro Wirebars...	,,	£120 0 0	—	4 0 0
H.C. wire basis......	per lb.	1s. 4$\frac{3}{16}$d.	—	$\frac{7}{16}$d.
Sheet..................	,,	1s. 6d.	—	$\frac{9}{16}$d.
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8$\frac{3}{16}$d	—	$\frac{7}{16}$d
Brass 60/40—				
Rod, basis	,,	1s 0d	—	$\frac{1}{4}$d.
Sheet, basis	,,	1s. 6$\frac{1}{2}$d.	1$\frac{1}{2}$d.	—
Wire, basis	,,	1s. 4$\frac{3}{4}$d	$\frac{1}{4}$d.	—
Iron—				
Cleveland Warrants	per ton	£10 7 6	£1 5 0	—
Galvanised steel wire, basis 8 SWG	,,	£44 10 0	£1 10 0	—
Lead Pig—				
English	,,	£50 0 0	—	£2 0 0
Foreign or colonial	,,	47 12 6	—	2 7 6
*Tin—*Ingot	,,	383 10 0	—	3 0 0
Wire, basis	per lb.	0 4 9	—	—

Salammoniac.—Per cwt. 95s. and 91s.

Sulphur (Flowers).—Per ton £22.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £7 18s. 9d.

Copper Sulphate.—Per ton £48

Boric Acid (Crystals)—Per ton £74

Carbon Bisulphide.—Per ton £56

Sodium Bichromate.—Per lb. 9d

Sodium Chlorate—Per lb. 5$\frac{1}{2}$d.

Rubber.—Para fine, 2s. 4$\frac{1}{2}$d.; plantation 1st. latex 2s. 5$\frac{1}{4}$d. per lb

Shellac.—T.N. Orange, 795s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd.

Forty Years Ago.

(The Electrician, March 20, 1880.)

The Albert Hall.—The management has decided to reintroduce the Siemens light, with the improvement recently made by Dr. Siemens.

Quadruplex.—Dr. Alexander Muirhead has successfully established the Muirhead and Winter quadruplex system on the land-line from Torbay, Nova Scotia, to New York of the Direct United States Cable route.

The Electric Light has at last been adopted in the Crystal Palace, and certain chilly mortals have, of course, found it to appear disagreeably cold. "They miss the warm comfortable appearance of gas." On the whole, however, the effect was a great improvement and the eye will soon get accustomed to the change of tint.

A "New" Electro Magnet.—M. Chambrin increases the surfaces presented to each other on the core-end and armature of an electro-magnet by forming a projection on the latter, which enters a hollow of the core, or, conversely, a projection on the core is made to enter the hollow in the armature. By this means he increases the portative force of the magnet on the armature nearly 100 per cent. The residual magnetism, too, is weakened by this device.

Reprinting "The Electrician."—A contemporary seems to imagine that reprinting a large portion of The Electrician without acknowledging the source is no very grave matter. There is, however, we may inform him, a well understood literary law which strongly condemns the morality of such a proceeding. It may lessen the cost of production in the case of our contemporary to extract our City reports, and reprint our notes, but it does not say much for his honesty when he allows the obligation to pass without acknowledgment.

The Battle of the Telephone Companies.—The Edison Telephone Company, fortified by the disclaimer to Edison's telephone patents, have stopped the Indiarubber, Gutta Percha and Telegraph Works Company, Ltd., from making the Blake transmitter for the Telephone Company (Bell's). The Edison Company holds the transmitter to be an infringement of their patents, and they are determined to take steps against any other company making these transmitters. There is no especial merit in the Blake transmitter that its disuse should seriously inconvenience the Bell Company, since Crossley's or any other good microphone will answer just as well.

The Holborn Viaduct.—Lieut.-Colonel Heywood, in his report for 1879, says:—"In regard to the electric lighting of the Holborn Viaduct, which was terminated on the 9th of March last year, the report says that the 16 lamps employed in a length of 473 yards (an area of 14,200 superficial yards) of roadway was £5 per night, or 6s. 3d. per lamp. No photometrical observations of the light were made; but, from figures given in the report to the Metropolitan Board of Works upo nthe electric light on the Thames Embankment, it might be reckoned that the lamps on the Viaduct gave, when unenclosed, about five times the light of ordinary gas lamps, and when enclosed in opal globes (as they were when in use), twice as much only, and that the actual cost was nearly four times that of gas."

The principal object of the Paper "On the Dynamo Electric Current and on Certain Means to Improve its Steadiness," by C. William Siemens, is to establish the conditions under which dynamo-electric machines worked on the shunt principle can be made to give maximum results. In constructing such machines on the shunt principle the resistance on the rotating helix has to be considerably reduced by increasing the thickness of the wire employed, and that on the magnets has to be increased more than tenfold, not by the employment of thin wire, but by augmenting the length and weight of coil wire employed.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics":—"Cairo-Cape Flights, why they Failed," by Major C. C. Turner; "Flying over Clouds"; and "The Governments' Attitude to Aviation."

"Cabinet Maker": "Practical Upholstering: Buttoned Work in Leather"; "Profit Sharing and Co-Partnership by Limited Companies"; and "A Day's Work."

"Chemical Age":—"Present Position of the British Fine Chemical Trade"; and "British Post-War Progress in the Manufacture and Use of Dyes for Pigment and Lake Colours."

"The Fruit Grower":—"Commercial Rose Growing, No. 3"; "London Market Problem"; and "Trade Charity's Record."

"The Gas World":—"The Place of Gas in the New Housing Schemes" "The Use of Gas in Industry"; and "Unsolved Problems of the Gas Engine."

"Hardware Trade Journal":—"Gas in Relation to Industrial Production and National Economy"; Institute of Metals: Presidential Address and Papers: and the London Fair and Market.

"Juvenile Employment" by W. Henderson Pringle; "Southern Russia," by Miss Evelyn Miller; and with this number is issued "Ways and Means"; "Miscontrol or Decontrol," a Study in Government Food Trading and Nationalisation, by Boyd Cable.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,184. [Vol. LXXXIV. No. 13.] FRIDAY, MARCH 26, 1920. PRICE ONE SHILLING. By Post, 1s. 1d. Abroad, 1s. 2d.

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Notes.

Income Tax Reform.

THE proposals of the Royal Commission for the reform of the income tax have attracted considerable attention, but we are afraid that the rejoicing caused by the recommendation to reduce the amount of the tax due from the smaller taxpayers will prevent the Report as a whole from receiving that careful scrutiny which it deserves. The injustice of the double income tax in the United Kingdom and in the Dominions is recognised, and certain suggestions are made for relieving the situation. This is an important question, and many Anglo-colonial and Anglo-foreign companies have already removed their headquarters abroad in order to avoid the British income tax.

The Question of Depreciation.

SOME of the proposals require close examination. For instance, it is recommended that, subject to the limitation that their life falls short of 35 years, an allowance should be given in respect of all inherently wasting material assets created by the expenditure of capital, such as buildings and foundations, surface works, permanent way and equipment of railways and tramways, &c. Depreciation should continue to be allowed on the written-down value of plant and machinery, subject to the taxpayer's right to have his depreciation calculated by the reference to the original cost of the asset. This allowance should not be restricted to traders. The obsolescence allowance should be given in the case of machinery or plant disused for any reason, whether replaced or not, except where the disuse is the result of the discontinuance of a business. In future any ordinary depreciation allowance and any obsolescence allowance should be regarded as trade expenses of the year whose profits are being calculated. "The allowance for renewals should be calculated by reference to the cost price of the machinery replaced." The allowance for depreciation of mills and factories should not be extended to other classes of buildings; it should be subject to the general conditions governing all allowances for wasting assets, and should not be a fixed percentage of the annual value. The present allowances of one-sixth and one-eighth of the annual value for repairs to property should be retained as the normal flat rates. Some of these suggestions are highly inequitable. The renewals allowance is totally inadequate as most machinery cannot now be replaced except at two or three times its original cost. The amount allowed for repairs is also insufficient, and we hope that an organised protest against these recommendations will be made.

Allowances to Scientific Workers.

IN connection with the new assessment of income tax, an attempt is shortly to be made to obtain certain concessions for scientific workers. At present doctors are allowed to deduct a sum from their assessable income for books and instruments, clergymen for books and the rent of their studies, and members of the Amalgamated Society of Engineers for the purchase of tools. Scientific workers are allowed to deduct nothing, in spite of the fact that many of them spend large sums in purchasing books and apparatus, in subscribing to societies, in renting laboratories and in travelling expenses. It would seem only equitable, therefore, that some form of relief should be extended to them. Requests of this kind are a direct result of a high income tax which seems to bear most hardly on those that can least afford it.

The Future of British Transport.

IN the evening of their days the thoughts of great men turn lightly to autobiography. The more modest among them call their efforts *apologia*, and by reading these effusions we have the gratification of learning the inmost thoughts of those who have made their mark. This is a time of great changes, and it has, therefore, apparently occurred to Sir ERIC GEDDES that it would be well to make his apology for the Ministry of Transport and himself (the two are synonymous) in advance. This he did—perhaps unintentionally—in his presidential address to the newly-formed Institute of Transport on Monday last. His argument for the existence of a Ministry of Transport, put briefly, is that competition causes waste. This was discovered before the war; for even then the railway companies were tending towards a pooling of interests—a tendency, which it is well to note, was discouraged both by legislators and officials. Nowadays no "transport agency," which is a convenient term to cover railways, canals and roads, could exist under pre-war conditions. They must either, therefore be allowed to increase their revenue or some means must be found for reducing their costs. It is the old old proposition. Amalgamations which were before forbidden will now be allowed, but means will be devised to prevent oppression of the public by trusts. In Sir Eric Geddes' view, another argument in favour of this course are the difficulties that have arisen with Labour. Railway companies and railway men can no longer be allowed to fight together without intervention. The community—*i.e.*, the Ministry of Transport—must be allowed to interfere in order that the community—*i.e.*, the inhabitants of this country—may not starve. The Ministry of Transport would also harmonise the operation of the different transport agencies in the interests of the community as a whole; in other words, it would run the whole show, saying to one you may carry this, and to another you may not carry that. The new era thus foreshadowed would certainly be a change, but whether it would be a change for the better is open to question. Incidentally, it is rather curious that in the same issue of The Electrician we should have to refer to the strictures of one Government department against the operations of a combine, and to the attempt of another Government department to erect a huge trust, which would not even possess the advantage of earning a dividend for its shareholders.

An Expert Inquiry.

It is pleasant to be able to turn from criticism to approval, even if it is of the Ministry of Transport. No fault can be found with the composition of the Committee that has been formed to report on the electrification of the railways of this country, for all the members know something about the subject, which in itself is matter for wonderment. Sir Alexander Kennedy is the chairman, and the members are Sir John Aspinall, Mr. A. R. Cooper, Mr. Philip Dawson, Sir Alexander Gibb, Mr. C. H. Merz, Sir Philip Nash, Mr. Roger Smith, Sir John Snell and Sir Henry Thornton, with Major Redman as secretary. It would be placing the intelligence of our readers at too low a value to explain in detail who these gentlemen are, but it will at least be agreed that if a Committee is necessary, it would hardly have been possible to appoint a better one. The Committee are to report whether any regulations should be made to ensure that the electrification of railways in this country is carried out in the best possible way with regard to such matters as the interchange of locomotives and stock, and uniformity of equipment, and how far it is desirable that railways, already electrified, should be altered so that they form parts of a unified system. The task of preparing regulations is also laid on the Committee. This is a wide and difficult field to cover, and we shall await with interest the publication not only of the report, but of the evidence on which it is based. We should also like to know the exact attitudes of, say, Mr. Dawson and Mr. Merz when the disadvantages of the single-phase and high-tension direct-current systems respectively are under discussion *in camera*. As Sir Eric Geddes pointed out in his presidential address to the Institute of Transport, it would be a service of great practical utility if that body were to act as an impartial umpire between alternating and direct current. The Committee will find some difficulty in doing this without sacrifice of someone's personal opinion.

Economies in the Boiler House.

That ever-present question of how best to conserve our fuel resources is considered from a fresh point of view in a Paper recently read by Mr. David Brownlie before the Institution of Mechanical Engineers. It is usual in matters of this kind to call attention to the economies which would result by the introduction of this or that new type of apparatus or by the employment of that or this unusual form of fuel. Those who put forward these solutions seem blissfully unmindful of the many boilers and engines in this country which it would obviously be impossible to scrap, but which must, nevertheless, receive some attention from reformers, if any great saving in fuel is to be achieved. Mr. Brownlie disdains theory. He investigates the working of eighty typical Lancashire boiler plants fired by mechanical stokers, and, on the basis of his results, points out the large saving in coal that could be effected were all the boiler houses in this country to be run on scientific, or even economical lines, which obviously they are not. As a result of this investigation, he finds that the average net working efficiency of the plants examined, including boilers and superheaters, and after deducting the steam or other power used to produce steam, was about 59 per cent. In three of the plants an efficiency of 75 per cent. or more was obtained. This gives an indication of what improvement may be effected by the use of suitable equipment, though those who swear by mechanical stokers will be piqued to learn that many of them as at present worked are giving worse results than is obtainable with hand firing. This, however, is surely a matter of proper design, careful maintenance and repair and attention to detail. No machine will work at its best if it is neglected, but that simple fact is, unfortunately, not always realised. If we accept Mr. Brownlie's figure of 75 per cent. efficiency as an attainable goal, it is estimated that 15 to 20 million tons of coal per annum could be saved on the present national consumption of 75 to 100 million tons used for steam raising purposes, while if this policy of economy were extended to the methods employed for utilising the steam this saving would be doubled. In the past we have treated our coal resources as an illimitable birthright, to be squandered as we pleased. Looked at from every point of view, this was a wrong policy, and it is well that circumstances are forcing us to change it. We are accustomed by now to thinking in millions, and Mr. Brownlie has given us something to think about.

A Check to Automatic Telephony.

A recent statement of the Postmaster-General must have come as a sad shock to those who hoped for the wider development of automatic telephony in this country. The failure to employ this method of communication more widely is apparently entirely due to economic reasons, and is based on the fact that in an automatic exchange where considerable use is made of trunk and junction circuits a large force of telephonists still have to be retained, while, as might be expected, the cost of the equipment, like everything else, has risen. While we are glad to see that one Government department is realising that economy is a matter worth considering, we should be sorry if fresh enterprise were to be scotched by such reasons as those put forward. They form another example of those circular arguments which, like the revolving drum in a dormouse's cage, gives the impression that great progress is being made, but ultimately finishes where it started. Another side of the question is to be seen in the annual report of the Automatic Telephone Manufacturing Company, a concern which depends almost entirely on the Post Office for its means of livelihood. Owing to the cessation of the development mentioned above, they are unable to make both ends meet on the year's working, and a scheme of reconstruction is under consideration. That the Post Office has ceased, at least temporarily, to develop automatic telephony is confirmed by a statement in the report of the British Insulated & Helsby Cables, Ltd. This is one of the disadvantages of a monopoly. The Post Office may have good reason for the course they have taken, but sudden changes in policy like this bring with them effects which, though not intentional, are nevertheless unfortunate. Moreover, it seems to be forgotten that no new system can be tested without considerable expenditure being necessary, and to expect such a system to pay at once is quite unreasonable. The seed must be sown before the harvest can be reaped.

A Topical Revenue Question.

At the present time, when many electric supply undertakings are charging their maximum price for electricity supply, and all undertakings are charging a fairly high figure, the question of the accuracy of the meters is important. The meter is undoubtedly in the majority of electric supply undertakings the weak spot in the chain of supply, and with high-priced units under-registration means a continual loss of revenue. Curiously, however, the importance of the meter question is one which is by no means widely appreciated. Meters are taken for granted, they are assumed to register correctly and to continue to register correctly for indeterminate lengths of time. Why they alone among electrical instruments should be thought infallible it is difficult to see. The seriousness of the question is that practically all the faults developing in meters as the result of a long period on service are in favour of the consumer. That is, faults due to dirt, rust and wear of moving parts, &c., slow the meter. It would be interesting to know the ripest age meters attain on circuit. Apparently, in some instances, if they have no breakdown in any individual part of their mechanism, they are left out on circuit till they collapse, like the "one-horse chaise" of Oliver Wendell Holmes. It is very questionable in many undertakings whether the precaution is even taken of periodically testing the meters for "starting," that is, seeing whether they will register with only one lamp in circuit, or whether the inertia is too great to admit the meter registering on less than the current for two or perhaps three lamps (according to capacity of meter). Considering the close watch that is almost universally kept on the cost of generation per unit, it is curious that the same attention is so seldom devoted to the registration per unit! There are some undertakings of course, which have the most complete arrangements in the way of meter-testing and meter-repairing and calibrating, and whose meters are periodically changed every few years—in some cases every three years. But there are also others.

The Wages Spiral.

The definition of a spiral staircase is well known. And the recent demands of the miners and railway locomotive staffs for a further large increase in wages may not inaptly be compared to that useful means of ascent. The claims are naturally based on the increased cost of living. Prices are now about 135 per cent. above pre-war level. When the miners received their last advance the figure was 110 per cent., while when the railwaymen's wages were last increased the figure was 115. From the narrowest point of view, there may be some justice in these demands, but when it is realised that to some extent the increase in the cost of living is caused by the increases in wages already granted the matter assumes another aspect, and becomes our old friend the vicious circle, or, rather, a spiral staircase, as an advance in a vertical direction is only too evident. The present cost of coal and the present freight charges are pressing heavily on all classes of the community. Without going into the politics of the matter, it is only too clear that a further increase in wages will mean still higher charges, and yet another depreciation in the purchasing power of the sovereign. Such increases can do no one any good, and they will do less good as time goes on. Electricity supply is a case in point. Coal is more expensive, freight charges are higher, the inevitable result is that the cost per unit generated is continually rising, and the natural corollary is that the price follows in the same direction. Our hopes of an "abundant and cheap" supply of power seem further off realisation than ever, and in a general way the benefits which cheapness brings in its train are fast receding into the distance.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

We publish a further instalment of Mr. H. H. Broughton's article on "Electric Winding Engines and Mine Hoists" (p. 340).

"The Electric Drive in Paper Mills" is dealt with in an article by Messrs. E. Tanner and G. F. Papworth on p. 344.

On p. 343 appears a short article by Mr. G. T. Southgate on "A 5,000 k.v.a. 100,000 v. New-Type Air-Break Switch."

Abstracts of Papers recently read before the Institution of Electrical Engineers by Mr. W. H. Patchell on "Operating a By-Product Producer Gas Plant for Power and Heating," and by Mr. S. H. Fowles on "The Production of Power from Blast Furnace Gas," are published on pp. 348 and 349. An account of the discussion which took place is also given.

On p. 350 is published an abstract of a Paper on "Earthing the Neutral of Generating and Transmission Systems," by Mr. H. R. Woodrow.

Our serial article dealing with interesting developments in electric heating and cooking appears on p. 352.

On p. 352 we publish reviews of Major Rupert Stanley's "Text-Book of Wireless Telegraphy," and of the recently published Life of the late Prof. S. P. Thompson.

Our leading article deals critically with the report of the Sub-Committee of the Standing Committee on Trusts on the Electric Lamp Industry (p. 355).

On p. 356 we publish an account of the Victory Works of Messrs. Scholey & Company, at Croydon, where mass production of electric vacuum cleaners and drills is carried out.

Arrangements for the Week.

FRIDAY, March 26th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Discussion on "Einstein's Theory of Relativity," introduced by Prof. A. S. Eddington, F.R.S.

Wireless Society of London.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Harmonics in Continuous Wave Transmissions," by Capt. L. A. T. Broadwood.

Wolverhampton and District Engineering Society.

7 p.m. At the Technical School, Garrick-street, Wolverhampton. Lecture on "Coal and Its By-Products," by Mr. J. R. Allett.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "The Future of the Gas Industry," by Mr. W. A. Tookey.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "The Scientific Work of the late the Right Hon. Lord Rayleigh," by Prof. Sir J. J. Thomson, O.M., P.R.S.

SATURDAY, March 27th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, London, W. Lecture on "Positive Rays," by Prof. Sir J. J. Thomson, O.M., P.R.S. (Lecture VI.)

Stoke-on-Trent Association of Engineers.

7 p.m. At the Town Hall, Hanley, Stoke-on-Trent. Annual Meeting.

MONDAY, March 29th.

Institution of Electrical Engineers.

7.30 p.m. At the Albert Tavern, 52, Victoria-street, London, S.W. Informal Social Evening, arranged by the Informal Meetings' Committee.

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London, W.C. Lecture on "Aluminium and its Alloys," by Dr. W. Rosenhain, F.R.S. (Lecture III.)

TUESDAY, March 30th.

Institution of Electrical Engineers (North-Western Students' Centre).

7.30 p.m. At Houldsworth Hall, Deansgate, Manchester. Paper on "The Financial Organisation of a Manufacturing Concern," by Mr. H. J. Brocklehurst.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. At Arts Building, The University, Liverpool. Lecture on "Elementary Calculus," by Mr. S. Clowes.

Illuminating Engineering Society.

8 p.m. At John-street, Adelphi, London, W.C. Discussion on "Motor-Car Headlights in Relation to Traffic Requirements," opened by Mr. J. W. T. Walsh.

Röntgen Society.

8.15 p.m. At St. Bartholomew's Hospital, London, E.C. General Meeting.

WEDNESDAY, March 31st.

Industrial League and Council.

7.30 p.m. At Central Hall, Westminster, London, S.W. "Safety First in Industry," by Mr. R. O. Roberts.

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(Continued from p. 289.)

Rating of Winder Motors.

When a winder is driven by a steam engine the size of the engine is fixed by the maximum torque. In the case of an electrically-driven winder the size of the driving motor is fixed from the average heating effect of the current in the armature. A motor sufficiently large to dissipate the heat generated in it without excessive temperature rise will work indefinitely under cyclical operation notwithstanding the fact that very heavy overloads of short duration may have to be handled several times during each cycle. Had the practice, which is correct for the steam engine, to be followed in determining the rating of an electric motor the machine selected would, in many cases, be from two to three times too large for the duty cycle owing to the inherent overload capacity of the electric motor.

The difference between the two methods of rating is an important one, and, as the heating of a motor armature is determined by the armature current, the reader will recognise the influence of the torque diagram on the rating of the driving motor when he remembers that torque and armature current are proportional in a motor having a field of constant strength.

To many who are accustomed to the making of winder calculations the author's treatment of the subject must appear tedious and never-ending. It is not for such men that these articles are written. In all likelihood during the next few years there will be a phenomenal development in electric winding†, and the men called upon to make decisions will be mechanical engineers having little knowledge of electric technology, and who find more theory than they are ever likely to need in a pocket book. It is for these that we are sacrificing our leisure, and shortly after the appearance of the first section of the article the author had convincing evidence that his purpose was being achieved. Suitable acknowledgment will be given when the articles are reissued in book form, but he takes this opportunity of expressing his appreciation of the encouragement and assistance that has been given, and which an author seldom receives.

Although we are not writing for those engaged in the making of winding engines, no doubt it will be of interest to them to know that prior to 1914 they lost business because their competitors on the Continent assisted their sales engineers by technical staffs which used methods at least as elaborate as those we are using in the present series of articles. Partly due to the lack of expert technical assistance in 1909-10 home firms lost £250,000 of winder business in South Africa in 250 days. There are signs which indicate that a much larger amount of business will, deservedly, be placed elsewhere in the near future.

Definition of Rating.—Two classes of rating are in common use. These are:

(*a*) Continuous Rating, which is used for machines intended for continuous service, is defined as the output at which a machine can work continuously for an unlimited period without undue temperature rise; and

(*b*) Short-time Rating, which is used for machines intended for intermittent service, is defined as the output at which a machine can work for a limited and specified period without undue temperature rise.

A Note to Clause 80 of the British Standardisation Rules for Electrical Machinery provides the key to a rational method of rating intermittent motors. The note referred to reads as follows:—

"When a machine will be required to work continuously with loads varying between very wide limits and the actual cycle of duty is specified, the machine may be given a Duty-cycle Rating, this being the continuous rating which is the thermal equivalent of the cycle of duty specified. A machine with duty cycle rating shall, in addition, be capable of withstanding a momentry load corresponding to the highest peak of load occurring in the cycle of duty specified.

In the case of a winder motor the cycle of duty is always more or less well defined, and the problem is to find a continuous load which produces the same heating effect on the motor as that produced by the intermittent load. In these articles we shall speak of the equivalent continuous load as the virtual rating.

Reference should be made to the ability of the machine to withstand the highest peak load. Although the peak horse-power may be momentary, it is the current input which determines the heating of the motor and, unlike the horse-power peak, the current peak persists during the whole of the accelerating period, namely, for a time which varies from a few seconds to as much as 30 seconds.

Effect of Altitude on Rating.—If a machine working in a temperate climate at or near sea level has a rating of, say, 1,000 H.P., then the same machine for a permissible temperature rise of 40 C. will have a rating of about 800 H.P. if set to work in a country in which the barometer stands at 640 mm. (25·2 in.).

The curve, Fig. 1, shows the relation between European and South African (Rand) ratings for a number of 50-cycle, 16-pole, 3-phase induction motors of large size.

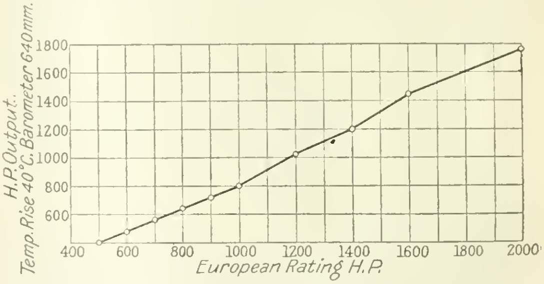

Fig. 1.—Relation between European and S.A. (Rand) Ratings.

In the British Standardisation Rules for Electrical Machinery it is stated that for a machine intended for service at an altitude above 3,300 ft. (1,000 metres approximately), the observable temperature rise if tested near sea level shall be reduced 2½ per cent. for each 1,000 ft. above sea level at which the machine is intended to work in service. The correction shall not be applied for altitudes below 3,300 ft.

In the Standardisation Rules of the American Institute of Electrical Engineers it is recommended that when a machine is intended for service at altitudes above 1,000 metres (3,300 ft.) the permissible temperature rise at sea level, until more nearly accurate information is available, shall be reduced by 1 per cent. for each 100 metres (330ft.) by which the altitude exceeds 1,000 metres. Water-cooled oil transformers are exempt from this reduction.

It is not clear from the British rule whether to allow $10 \times 2\frac{1}{2} = 25$ per cent. or $(10 - 3{\cdot}3)\ 2\frac{1}{2} = 16\frac{3}{4}$ per cent. for an altitude of 10,000ft. above sea level. For the altitude named the American rules recommend a reduction of 20 per cent. The example serves to emphasise the importance of making the reduction in the case of machines intended to work at high altitudes.

Determination of Virtual Rating.—By virtual rating is meant the continuous and constant output that produces the same temperature rise as the fluctuating and intermittent output.

Referring to Fig. 2 (*a*) imagine the curve *o a b c*, &c., to represent torque plotted to a time base. The torque exerted by any motor is due to the action of one magnetic field on another, and is proportional to the product of the two magnetic fields. If one of these fields be constant the torque is directly proportional to the other. In most winder motors the main field is of constant strength and the torque exerted by the armature is directly proportional to the armature current. It follows, therefore, that the curve *o a b c*, &c., also represents the armature current to some scale.

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† It is said that no less than 400 standardised electric winders will be required in the near future in a certain mining district.

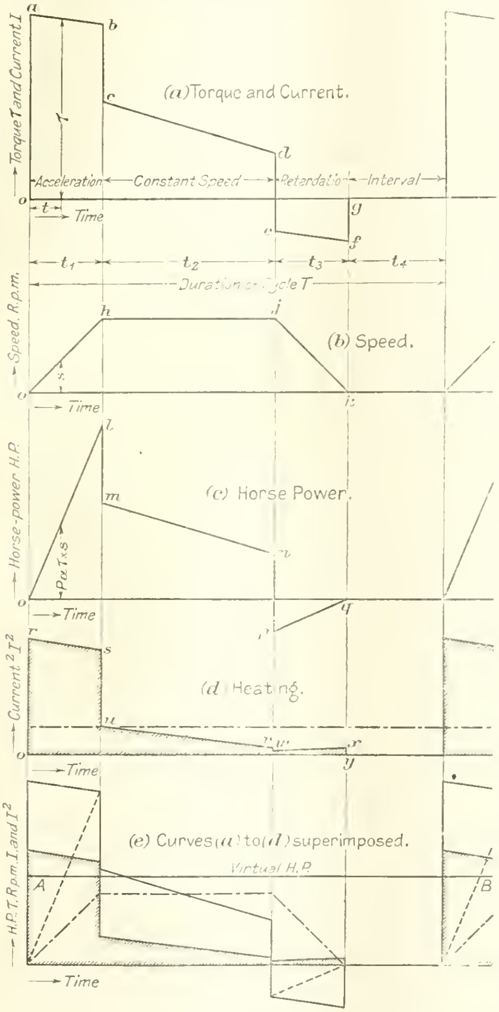

FIG. 2.—DETERMINATION OF VIRTUAL OUTPUT.

The speed at every instant is represented by the curve *o h j k*, Fig. 2 (*b*), and the power at any instant is proportional to the product of torque and speed at the said instant. Thus *t* sec. after the commencement of the run, the torque is τ from Fig. 2 (*a*), the speed is *s* from Fig. 3 (*b*), and the power is $P \propto \tau s$, as shown in Fig. 2 (*c*). Other points can be determined in like manner, and the power curve *o l m n*, &c., obtained.

From the diagrams, Fig. 2, it will be noted that, although both the speed and output are zero at the time $t = o$, the motor torque and the armature current are a maximum at this instant. Since the heating effect of a current is proportional to the square of the current it is evident that the heating effect is very large during the whole of the accelerating period, and is a maximum when $t = o$, that is when the motor is at rest.

In the common method of fixing the virtual rating of a winder motor it is assumed that the heating at any instant is proportional to the square of the current at the instant. Suppose that the whole of the ordinates of the current diagram *o a b c*, &c., Fig. 2 (*a*) have been squared and plotted separately in Fig. 2 (*d*). The problem is to find the constant H.P. output which necessitates dissipation of a certain number of units of heat, represented by the cross-hatched area, Fig. 2 (*d*), in *T* sec., *T* being the duration of the cycle, including the interval.

Since a constant H.P. output is sought it follows that the heating effect is constant and, assuming for the moment that the dissipation of heat is independent of the speed of the motor, it is evident that the constant heating effect is found by dividing the cross-hatched area by the time *T*. In other words the area *o r s u*, &c., in Fig. 2 (*d*) is equal to the cross-hatched area. The constant output, which is thermally equivalent to the variable output, is equal to the square root of the ordinate *o r*, and is represented by the line *AB* in Fig. 2 (*e*).

As is well known, the rate of dissipation of heat depends on the speed of rotation of the armature. With the motor running at full speed the cooling surface, being well scrubbed with cold air, is more efficient than when the armature is running at reduced speed, and the machine is least efficient as a radiator when the armature is at rest. Experience shows that for alternating current motors the cooling surface is only about half as efficient during reduced speed periods and about one-quarter as efficient at standstill as it is when the motor is running at full speed. The corresponding figures for direct current motors are, during reduced speed periods 0·75, and during standstill 0·5.

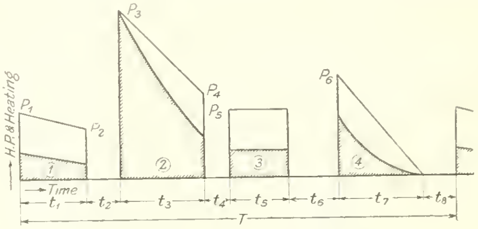

FIG. 3.—CURRENT AND HEATING CURVES.

The varying efficiency of the cooling surface can be allowed for by reducing the duration of the cycle *T* to an equivalent full-speed value T_e. Thus, referring to Fig. 2 (*a*), let

t_1 = accelerating period, sec.
t_2 = constant-speed period, sec.
t_3 = retarding period, sec.
t_4 = interval, sec.,

then, equivalent full-speed value of the cycle

$$T_e = \alpha t_1 + t_2 + \alpha t_3 + \beta t_4 . \qquad (1)$$

where α and β are constants depending on the type of motor. For alternating current motors $\alpha = 0{\cdot}5$ and $\beta = 0{\cdot}25$, and for direct current motors $\alpha = 0{\cdot}75$ and $\beta = 0{\cdot}5$.

Although the method described above is based on assumptions which are not strictly correct, the method nevertheless gives results which are sufficiently accurate in most cases. In addition it has the very great advantage of being easily applied.

We will illustrate the method by the following examples :—

Example.—The load on a motor varies from instant to instant as shown in Fig. 3, and during the whole of the time the motor runs at constant speed. It is required to find the rating of the motor.

Since the speed is constant, horse-power is simply proportional to torque. With constant excitation torque is proportional to current, therefore H.P. and current are proportional. Hence it follows that by squaring the ordinates of the power diagram and plotting to the same base, a diagram is obtained which represents the heating of the armature. The diagram referred to is represented in Fig. 3 by the cross-hatched areas (1) to (4).

Since there is little difference between P_1 and P_2, the area of the portion (1) is given with sufficient accuracy by the expression

$$\text{Area (1)} = \tfrac{1}{2}(P_1^2 + P_2^2)\, t_1. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The difference between P_3 and P_4 is considerable and it is easily shown that

$$\text{Area (2)} = \tfrac{1}{3}(P_3^2 + P_4^2 + P_3P_4) \cdot t_3. \quad . \quad . \quad . \quad . \quad (3)$$

In the case of the third portion of the diagram the power P_5 is constant, and

$$\text{Area (3)} = P_5^2 \cdot t_5 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The power varies uniformly from P_6 to 0 in the fourth portion of the load diagram and the heating is found from equation (3) to be

$$\text{Area (4)} = \tfrac{1}{3}P_6^2 \cdot t_7 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Hence

$$\text{Total Area} = \frac{t_1}{2}(P_1^2 + P_2^2) + \frac{t_3}{3}(P_3^2 + P_4^2 + P_3P_4) + t_5P_5^2 + \frac{t_7}{3}P_6^2$$

Dividing the total area by the duration of the cycle we get

$$\text{Average heating} = \left\{\frac{t_1}{2}(P_1^2 + P_2^2) + \frac{t_3}{3}(P_3^2 + P_4^2 + P_3P_4) + t_5P_5^2 + \frac{t_7}{3}P_6^2\right\} \div T,$$

and, since heating is directly proportional to the square of the power, it is evident that the load which, when constantly applied, is thermally equivalent to the given variable load is equal to the square root of the average heating, or

$$\text{Virtual H.P.} = \sqrt{\left[\left\{\frac{t_1}{2}(P_1^2 + P_2^2) + \frac{t_3}{3}(P_3^2 + P_4^2 + P_3P_4) + t_5P_5^2 + \frac{t_7}{3}P_6^2\right\} \div T\right]}.$$

In the next example but one it will be shown that by proceeding in an orderly manner the application of the method is straightforward.

Example.—The load diagram for a cylindrical-drum winder without tail-rope is represented in Fig. 4 by the diagram $OP_1P_2P_3$, &c., and the speed of the motor varies as shown by the curve *Oabc*. Determine the virtual H.P. of the three-phase induction motor.

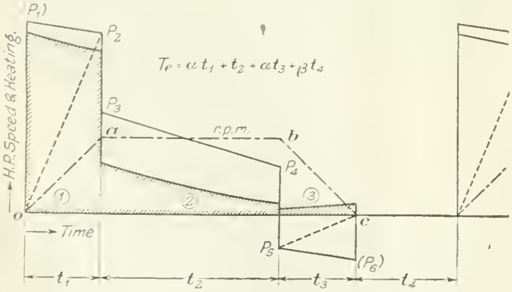

Fig. 4.—Diagrams for a Cylindrical-drum Winder.

In the diagram, Fig. 4, it will be seen that at the beginning and end of the wind the power or load is put within brackets, thus :—(P_1) and (P_6). Throughout these articles all loads expressed in this way denote fictitious loads corresponding to those that would be developed by the motor if it were running at full speed. Although the actual power developed by the motor at the beginning of the wind is zero, the torque is a maximum at this instant and the current input is, therefore, a maximum. Hence at this point the motor heating is a maximum.

The motor heating curve, found by squaring the ordinates of the power curve, is represented by the cross-hatched diagram whose

$$\text{Area} = \frac{t_1}{2}(P_1^2 + P_2^2) + \frac{t^2}{3}(P_3^2 + P_4^2 + P_3P_4) + \frac{t_3}{2}(P_5^2 + P_6^2).$$

Since the cycle includes an accelerating period t_1 a constant-speed period t_2 and a retarding period t_3 in addition to an interval of rest t_4 it is necessary to reduce this by means of equation (1) to an equivalent full-speed period T_e in order to find the average heating effect. Using the constants given with equation (1) we get equivalent full-speed period

$$T_e = 0{\cdot}5\,(t_1 + t_3) + t_2 + 0{\cdot}25t_4.$$

$$\text{and average heating effect} = \frac{\text{Area of cross-hatched diagram}}{\text{Equivalent full-speed period}}$$

$$= \frac{\frac{t_1}{2}(P_1^2 + P_2^2) + \frac{t_3}{3}(P_3^2 + P_4^2 + P_3P_4) + \frac{t_3}{2}(P_5^2 + P_6^2)}{0{\cdot}5(t_1 + t_3) + t_2 + 0{\cdot}25t_4}.$$

Finally, the virtual rating of the motor is equal to the square root of the average heating effect, or
Virtual H.P.

$$= \sqrt{\left\{\frac{\frac{t_1}{2}(P_1^2 + P_2^2) + \frac{t_3}{3}(P_3^2 + P_4^2 + P_3P_4) + \frac{t_3}{2}(P_5^2 + P_6^2)}{0{\cdot}5(t_1 + t_3) + t_2 + 0{\cdot}25t_4}\right\}}.$$

The arithmetic of the method is less tedious than the algebra as we shall now proceed to show.

Example.—The torque conditions for the cardinal points of the cycle of operations of a Ward Leonard winder for a compound shaft are given in Fig. 5. The cylindrical drums are 10ft. diameter and the maximum winding speed is 2,500 ft. per min. An open-type direct-current motor coupled to the drum shaft is used for driving purposes, and it is required to find the rating of this motor.

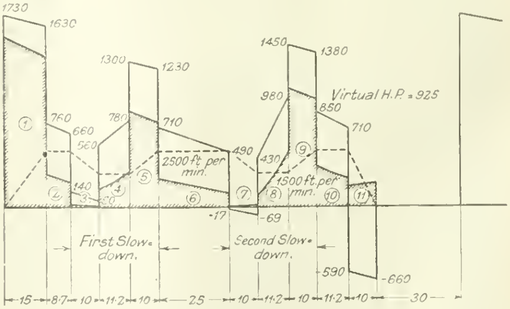

Fig. 5.—Winder Diagrams for Compound Shaft.

From the given maximum speed and drum diameter it follows that the drum-speed = 2,500 ÷ $10\pi = 79{\cdot}6$ revs. per min. Knowing the torque and the drum speed, the horse-power at the drum shaft is found by means of the expression

$$\text{H.P.} = \frac{\text{Torque (lb. ft.)} \times \text{Angular speed (radians per min.)}}{33{,}000}$$

$$= \tau \times 2\pi \times 79{\cdot}6 \div 33{,}000$$

$$= 0{\cdot}0151\,\tau.$$

The torque values when multiplied by 0.0151 give the H.P. values from which the rating of the motor is determined.

Thus

$$\text{Area (1)}=(1{,}730^2+1{,}630^2)\times\frac{15}{2}\ \ldots\ldots = 42{\cdot}5\times10^6$$

$$(2)\ (760^2+660^2)\times\frac{8{\cdot}7}{2}\ \ldots\ldots = 4{\cdot}42\times10^6$$

$$(3)=(140^2+50^2)\times\frac{10}{2}\ \ldots\ldots = 0{\cdot}11\times10^6$$

$$(4)=\{560^2+780^2+(560\times780)\}\times\frac{11{\cdot}2}{3}\ \ldots = 5{\cdot}07\times10^6$$

$$(5)\ (1{,}300^2+1{,}230^2)\times\frac{10}{2}\ \ldots\ldots = 16{\cdot}01\times10^6$$

$$(6)=\{710^2+490^2+(710\times490)\}\times\frac{25}{3}\ \ldots\ldots = 9{\cdot}10\times10^6$$

$$(7)=\{(-17)^2+(-69)^2\}\times\frac{10}{2}\ \ldots\ldots = 0{\cdot}03\times10^6$$

$$(8)=\{430^2+980^2+(430\times980)\}\times\frac{11{\cdot}2}{3}\ \ldots = 5{\cdot}84\times10^6$$

$$(9)=(1{,}450^2+1{,}380^2)\times\frac{10}{2}\ \ldots\ldots = 20{\cdot}03\times10^6$$

$$(10)=\{850^2+710^2+(850\times710)\}\times\frac{11{\cdot}2}{3}\ \ldots = 6{\cdot}03\times10^6$$

$$(11)=\{(-590)^2+(-660)^2\}\times\frac{10}{2}\ \ldots\ldots = 3{\cdot}92\times10^6$$

$$\text{Total area}\ \ldots\ldots\ldots\ldots \quad 113{\cdot}06\times10^6$$

In the cycle, besides accelerating and retarding periods and an interval of rest, there are two reduced-speed periods and three full-speed periods as shown by the dotted speed-time curve in Fig. 5. The equivalent full-speed value of the cycle is, therefore.

Period.	Actual time, sec.		Equivalent time, sec.		
Initial acceleration ...	15·0	......	15×0·75	—	11·25
First full-speed	8·7	......			8·7
First slow-down	31·2	......	31·2×0·85	—	26·5
Second full-speed ...	25·0	......			25·0
Second slow-down ...	31·2	......	31·2×0·85	=	26·5
Third full-speed	11·2	......			11·2
Final retardation	10·0	......	10×0·75	=	7·5
Interval	30·0	......	30×0·5	=	15·0

Equivalent full-speed time ....131·7 sec.

Having found the area of the heating curve and the equivalent full-speed value of the cycle, the rating is determined from the expression

$$\text{Virtual H.P.}=\sqrt{\frac{113{\cdot}06\times10^6}{131{\cdot}7}}$$
$$=925.$$

(To be continued.)

A 5,000 kva., 100,000 Volt New-Type Air-break Switch.*

By GEORGE T. SOUTHGATE.

A new type of air-break switch, designed by the writer and tested on a 100,000-volt line at Raleigh, N.C., can consistently interrupt the charging current of 100 miles of line. Such a current is much more difficult to break than a higher power-factor load, so that the rating of 5,000 k.v.a., which corresponds to this performance, should not be confused with the breaking capacity with a power load. The unit reached the limit of its successful performance with about 125 miles of 100,000-volt line connected. Three other units are now permanently installed at an important sub-station for further test under operating conditions. The tests which were made were conducted with increasing currents and varying winds.

The construction of the switch is shown in the diagram. Unlike other air-break switches now available, the insulators carrying the arcing horns and contacts do not swing or pivot about their ends, but rotate on their own axes. Thus, the contacts and horns do not retreat from each other through a vertical plane through the two insulators but along curved surfaces that have more of a horizontal than of a vertical direction.

While the switch is suitable for use as a circuit breaker on light loads or wherever an oil switch would be prohibitively expensive, as at sub-stations for small-load taps from large transmission systems, its most important service is as a mechanically operated three-phase disconnecting switch. For use between oil switches and 'buses or as selectors for feeders taken from double-'bus systems, the switch has the following advantages :—

1. The cost of manufacture is low, because the electrical parts are essentially the same as those of pole-operated knife switches and the number of insulators (the most expensive single part) is the same as in knife switches ; the mechanical parts—the structure and mechanism—are simple.

2. The switch can be used in any position on any type of structure and either indoors or outdoors. By virtue of its compact, self-contained construction a switch can be set upright or mounted sidewise or hung under a 'bus structure.

Throughout the complete range of voltages for which this switch is designed the parts are absolutely identical and standard equipment, with the sole and advantageous exception of the horns, masts and pipe supports for the contact wheels. These are proportional in lengths to the number of discs and heights of the insulators. Thus, 46 of the 49 parts required can be taken from stock to assemble any switch for 70 kv. to 140 kv. rating.

The switch illustrated is rated at 110,000 volts 300 amperes. The bolt through each contact support and tension spring enable the separation of the contact discs to be adjusted. Because of the floating arrangement of the contact discs they make contact with each other over their entire bearing surface. The positions of the contacts and horns are adjusted by moving pipe and mast attached to these parts. The insulating joint on each mast is to induce the current to secure that the magnetic blow-out effect for stretching the arcs will be a maximum.

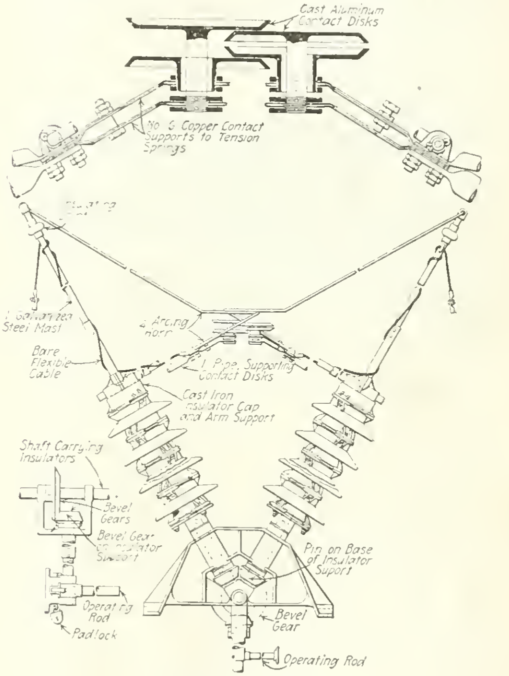
Cast Aluminum Contact Disks
No 6 Copper Contact Supports to Tension Springs
1 Galvanized Steel Mast
2 Arcing Horn
Bare Flexible Cable
1 Pipe, Supporting Contact Disks
Cast Iron Insulator Cap and Arm Support
Shaft Carrying Insulators
Bevel Gears
Bevel Gear on Insulator Support
Pin on Base of Insulator Suport
Operating Rod
Padlock
Bevel Gear
Operating Rod

Diagram of Switch.

In opening the switch the horns are drawn apart with their convex sides facing each other. In so retreating the shortest separation between the horns is always approximately in the median plane of their closed contact. Rotation of the insulators carrying the horns and contact discs is accomplished by means of a bevel-gear mechanism at the base of the switch. On the lower end of each insulator is a bevel pinion, which meshes with a bevel gear, in turn driven by another bevel pinion attached to the operating rod. The bevel gear is not a complete circle, but embraces an arc slightly over 120 deg. The end teeth of this sector extend sufficiently to bear against the base of the switch when at extreme ends of its travel. Thus the stopping of opening and closing is done neither at the contacts, which would be injured by the impact, nor at the operating handle, which would allow lost motion in the mechanism to interfere with accurate closing. The gears can be enclosed

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* Abstract of an article in the "Electrical World."

The Electric Drive In Paper Mills.

By E. TANNER and G. F. PAPWORTH.

The great strides made in the improvement of electrical equipment during the last 10 years for heating, lighting and the transmission of power, with which latter this article is chiefly concerned, has secured for it a place of the first importance in all manufacturing industries; and perhaps in no other industry is it making greater headway or proving its possibilities in every direction than in the manufacture of paper. The ever increasing demand for the rapid production and greater output of paper is to-day rendered possible by the judicious application of electrical energy in the various processes of manufacture, from the handling of the raw material to the despatch of the finished paper.

It is the intention in this article to take the reader through a large paper mill in the south of England, completed just prior to the war, engaged in the manufacture of "news" and "fine printings" from wood pulp, with an average weekly output of 1,500 tons of paper; making a survey of the electrical installation, paying particular attention to electrical energy as applied in the transmission of power showing how, octopus like, it has stretched its tentacles throughout the whole fabrication.

General Considerations.

Perhaps a few opening remarks on paper mills generally and the electrification thereof would not be out of place here.

The phrase "judicious application of electrical energy" was just now used, and advisedly, for almost the first point to consider is in what degree it is proposed to electrify a mill, or, again, how far it is possible to apply electrical energy. With regard to the former, the "degree" of electrification, so much depends on the site, and here the word "site" is intended to embrace all possibilities, whether it be an entirely new plant that is under consideration or an old plant that is to be modernised, in relation to the employment of mechanical energy direct or the conversion of mechanical energy into electrical energy and the reconversion of electrical energy into mechanical energy, as applied to the transmission of power from an economic standpoint that, save for an example by way of illustration, it is not proposed to enter into lengthy discussion on this point.

For example then, in those countries fortunate enough to possess large volumes of water rushing down in mighty falls, as in America, Norway, &c., it would be foolish to ignore the possibilities open to the exploitation of such a natural source of power by suitably harnessing the water, introducing turbo-generators and employing the "limit" of electrification possible. Not being in possession of such a source of power in this country we must turn our attention to other available motive powers such as steam, oil and gas. Further, if the reader will bear in mind the fact that large quantities of steam are required in the manufacutre of paper for drying purposes, the proportion being 55 per cent. for drying and 45 per cent. for motive power in a mill where main shaft steam engine and machine steam engines are found to be most economical, he will see that the word "judicious" is fully justified.

The Effect of Site on Electrification.

One other remark in relation to "site" as bearing on the "degree" of electrification. Where a cheap, abundant and certain supply can be obtained from an Authority, or where it is found necessary to build several storeys high, though this is not to be favoured in a paper mill, electrical energy as a means of power transmission should be employed to the limit as it possesses a decided economic advantage over the heavy shafting, pulleys, ropes, belts, gearing, &c., otherwise necessary, which are cumbersome, light obstructing, occupy a large amount of room and are costly in upkeep. This latter remark may appear, in part, a contradiction of the preceding paragraph, but by "Authority" is intended what all manufacturers hope for one day, large, very large, central stations from which they may draw a practically unlimited supply of energy at a very cheap rate. Such stations must be State controlled, for it should not be in the power of a few individuals to paralyse trade by cutting off the supply.

The Possible Limit of Electrification.

Now let us consider the possible "limit" of electrification, in relation to which we would like to draw the reader's attention to a very instructive article in "Papermaking" of February, 1919, entitled "An Electrified Paper Mill," which states that practically all the operations in the mill described are performed through the medium of motor drive. This "degree" of electrification is rendered possible by the fact that the motive power available for the large amount of electrical energy produced is water. This would indicate that there is practically no limit to the electrification possible in a mill.

The extreme flexibility of electrical energy which enables one, regardless of the position of the prime mover, to lay out the plant in the best possible manner with a view of ensuring the greatest facility in handling the paper, combined with the cleanliness so essential in a paper mill, ease of control and small space required for motor and equipment are all big points in favour of its increased adoption for driving the auxiliary machinery, as apart from the paper-making machine itself, of a paper mill.

With regard to the driving of a paper-making machine by electricity, thereby dispensing not only with the machine steam engines at present employed but also displacing the maze of gearing, large cone pulleys, giving the necessary and many variations of speed, belts, ropes, &c., it might be said, that although systems, one of which is described later, have been devised to meet the very complicated requirements of the inter-speed control of the several sections in a paper-making machine, they are not, at present, greatly favoured by paper manufacturers in this country. To bear out this latter statement there is a large firm of engineers in the North with orders for about 30 paper machines, all of which will employ steam engines as hitherto.

Generating Plant.

Sufficient has, perhaps, been written in a general way to serve as indication that the application of electrical energy in a paper mill demands the closest attention; so let us now pass on to the particular mill which is taken as a basis for our examination.

The generating plant installed consists of two 400 kw. and one 200 kw. direct current generators of the six pole type, shunt wound with interpoles. One of the former is rope driven from the main engine second motion shaft, the engine being of the horizontal compound slow speed type. This engine has a capacity of 1,500 h.p., and is used for driving the whole of the beating plant. This method of dynamo driving while open to criticism as having the disadvantage of interruption through a "shut down," is exceptionally economical, and in this particular mill, where a "shut down" is a very rare occurrence, has fully justified itself in every way; so much so that a further 400 kw. direct current generator driven in the same manner is contemplated in connection with proposed extensions to the mill. The remaining two generators, that is one 400 kw. and one 200 kw., are direct coupled to two high-speed vertical steam engines.

Other methods, such as employing mixed pressure turbines using exhaust steam from the main engine, could be quoted as examples of modern practice, each method standing on its merit in relation to questions of site, &c., before mentioned.

The installation is on the three-wire system, the voltage being 160 across the outers and 230 between outers and neutral. The out-of-balance current is regulated by static balancers connected through three slip rings mounted on the armature shaft to three armature tappings in each instance.

The switchboards are of the "unit-panel" type, there being an additional panel for an outside municipal supply. This is used during week-ends when, the power plant being stopped, repairs, &c., are necessary throughout the mill, and is also as an "emergency supply" for lighting and driving essential units in event of a breakdown. Where such an outside supply forms a "constant" and not as in this case an "emergency" supply, an alternative route for the cables to the mill should be provided in case of injury.

Each switchboard panel is fitted with a 1,000 ampere double pole circuit breaker, two ammeters, a triple pole knife pattern main switch and "Westinghouse" watt-hour meter. An earth recording ammeter and switch are, of course, also installed. The shunt regulating resistances are situated behind the switchboard, being connected by chain drive to a suitable operating handle on the panel.

The total average output of this generating plant per week of 132 working hours is 62,000 units, which are utilised as follows: 20 per cent. for lighting, 15 per cent. for heating, and 65 per cent. for power transmission. This, of course, falls short of the total weekly consumption by the amount drawn from the municipal supply.

In the event of any serious breakdown to the generating plant during the "peak-load" period, the possibility of interruption to any electrically driven plant that may be vitally essential to the running of the mill generally, such as the main water pumps for example, has been greatly minimised by the installation of a separate "town" supply direct to the pumping station, which is situated at some distance from the mill. This supply, being absolutely independent, enables the water supply to be maintained at all times. The importance of this will be realised when it is said that a supply to the fire mains is always necessary.

THE LIGHTING AND HEATING INSTALLATION.

Let us briefly survey lighting and heating methods before passing on to the application of power transmission. It being essential that the beater house, where the raw material is pulped into various degrees of fineness, and the machine house, where the paper is made, should be well illuminated, the incandescent system has been adopted, "three-light" fittings with "anti-vibration" holders being employed. These are suspended from the roof and are fitted with 100-watt "Osram" vacuum type lamps. Recently, in some instances these have been replaced by the 100-watt half-watt type with varying degrees of success. The whole of the interior wiring is in screwed steel conduits with the exception of those buildings in which chemical action has to be contended with; such as the machine houses, where the vapour given off during the drying process has led to the adoption of galvanised conduit with excellent results; and in the drainer house, where the fumes given off from the bleached pulp has necessitated "surface wiring" supported on porcelain knob insulators. Vulcanised india rubber insulated cable has proved highly efficient. By these means a fault is easily detected. In these instances the three-light fittings are made up of sheet copper heavily enamelled, successfully withstanding any chemical action to which they may be subjected. Every building is equipped with "emergency" lighting supplied through the "town" panel and controlled by the switchboard attendant in the event of the mill supply failing. The whole of the wiring has been carried out on the basis of 800 amperes per sq. in. of copper; all fuse boards and switches being thoroughly fire-proof.

Ventilation is obtained by means of electrically driven intake and exhaust fans suitably disposed throughout the mill, and perhaps the system adopted in heating and ventilating the machine houses is worthy of short description.

It being essential to maintain an even temperature in the machine house to ensure uniformity of the final product, it becomes imperative to adopt an efficient system of heating and ventilating to counteract the outside atmospheric conditions. The system employed consists of blowing, by means of an electrically driven blower, hot air in the form of superheated steam through a range of pipes, having numerous outlet branches, placed near the underside of the roof. This prevents condensation of the vapour given off from the paper-making machine, which vapour is carried away by means of electrically driven exhaust fans, suitably placed in the roof. A variable speed motor is employed which enables the amount of hot air admitted to the machine house to be regulated to suit the varying outside atmospheric conditions. An illustration of one of these installations is given in Fig. 1.

With regard to heating generally, "open-fire" type radiators are employed, the heating element being wound spirally and mounted on porcelain grids; the consumption is approximately 13 amps. per radiator. All radiators are supplied from lighting distribution boards at 230 volts, these in turn being supplied from a power distribution board carrying both "outers" and "neutral." Two lighting boards are supplied from each power board in every instance, almost perfect balance being thereby attained.

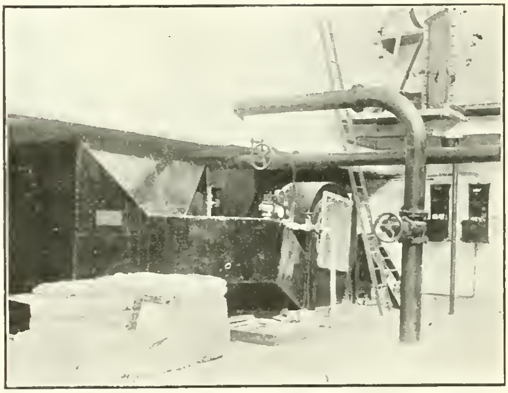

FIG. 1.—ONE OF SEVERAL INSTALLATIONS FOR HEATING MACHINE HOUSES BY MEANS OF ELECTRIC BLOWERS AND DRY STEAM.

Electric stoves of the ironclad totally enclosed pattern are provided to heat the irons used in jointing the paper during the process of reeling.

The reader may consider heating, &c., has been dealt with rather too fully. In excuse, the writers urge the importance of its inclusion as showing how necessary electricity has become in those industries where the manufactured article is of an inflammable nature, therein requiring the utmost protection from fire.

THE POWER INSTALLATION.

We come now to the question of power transmission, it being the intention to give in detail a description of the more important features, beginning with the outside electrical equipment, going through each department of the mill, and summing up with a few general remarks.

The discharge of ships arriving with the raw material, in this case pulp, is effected by means of two electric jib cranes which unload the pulp into trucks. One of these cranes is equipped with a separate motor for each movement, that is, hoisting, slewing and luffing, which are controlled by a drum-type controller, while the other crane is operated by a single motor of 35 h.p., the various motions being obtained through interchangeable gear, the question of their respective merits forming no part of a discussion here.

The loaded trucks are drawn into the pulp-stacking yard, where they are unloaded and stacked by means of five electric travelling cranes (*see* Fig. 2) running on gantries about 30 ft. high, with a span of 50 ft. and a run of 600 ft. Three motors of the series traction type are housed in the travelling cabin, controlled by the usual drum controller. Each motor is an entirely independent drive in itself, and the three controllers are so situated by the driving seat as to permit of the simultaneous operation of the three movements, travel, traverse and hoist, when necessary. For the rapid handling of the large quantities of pulp used these cranes are ideal. In certain cases a second crane has been installed on the gantry, as the mill is also served by means of a platform running from the beater house across the pulp yard on to which the crane deposits the bales as required, thus enabling the stacking and delivery to be carried out simultaneously. Coal from ship, barge or truck is also dealt with by means of an electrically operated transporter, separate motors again being used for the several movements. The transporter, being of the endless wire and grab type, is too well known to warrant description.

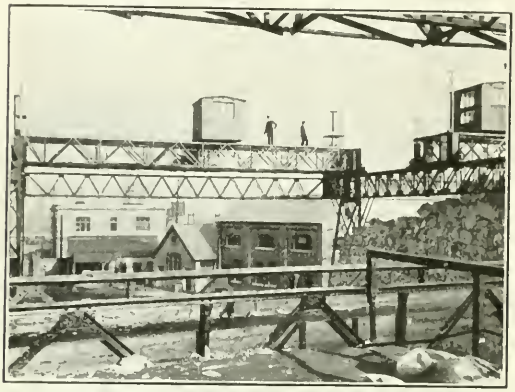

Fig. 2.—Pulp Conveyor with Travelling Cabin.

Passing now to the interior electrical equipment and starting from the feed-pump house supplying the boilers, it may be noted that pumps of the centrifugal type are used throughout the softening plant system (a very extensive one here owing to the nature of the water), and are direct coupled to motors of variable speed. The economisers, used for heating the feed water before entering the boilers, have the soot scraper gear electrically driven through belt drive, while all pumps in connection with hot water from the main engines employ a direct coupled motor duplicated as an emergency.

The Beater House.

From the engine house we come to the beater house, where the pulp is beaten; the bulk of this plant, as indicated elsewhere, is driven from main engine second motion shaft. But several "stuff" pumps in connection therewith are electrically driven, either by belt or direct coupled to the motor. Mention here should be made of the very important part electrically driven pumps play in dealing with the large amount of waste water, known as "effluent," which must be rapidly disposed of or flooding results. More especially is their importance proved when a "wash-down" of machines and plant takes place.

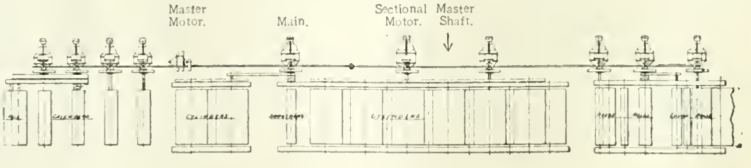

Fig. 3.—Diagram of the Harland Drive.

In the machine house itself, although, as mentioned, the paper-making machines are steam driven, it is well to observe that a certain pump, termed the "back-water" pump, draining one of the machine pits, is electrically driven by a 13½ h.p. totally enclosed motor employing a belt drive. It has been found convenient to control this pump from the beater house as a certain amount of the back-water is required in the beaters, &c., such water being stored in a tank situated on the beater floor. For obvious reasons an ammeter is fitted to the starting panel. This is a very excellent arrangement and a good example of the value of electricity where distant control is required.

The electrically driven paper-making machine is operated on what is known as the "Harland Patent Speed Interlock." A paper machine is divided into several sections, each section running at a different speed, the difference between any two adjacent sections being a very small one, but necessary to overcome the variation in the length assumed by the paper during manufacture, owing to contraction as it passes from the "wet end" through the presses round the drying cylinders, finally passing from the calendar at the "dry end" of the machine as finished paper. The general practice met with in this country to obtain the speed variation required is to employ a high-speed vertical steam engine, the exhaust steam from which is utilised in the "drying" cylinders, in conjunction with large cone pulleys using a belt drive, the gearing, shafting, &c., entailed thereby being massive and heavy.

The introduction of electricity as a power agent presents enormous possibilities in this direction; the use of a direct current motor driving each individual section of the paper machine enables the speed to be varied at will with the greatest ease, but the inherent properties of motors are such that, failing a positive inter-lock speed controller, the inter-speed relationship under varying conditions cannot be made to remain constant, as a result of which excessive "broke" would occur.

Several attempts have been made to secure a controller answering these requirements, but, until the introduction of the "Harland Patent Speed Interlock" none had met with the general approval of paper manufacturers. This system employs a shaft, known as the "master shaft," running the entire length of the machine and driven by a tiny "master motor." This shaft, in turn, drives, by means of bevel gears, a spur shaft, there being as many bevel gears and spur shafts as there are main sectional motors driving the several sections of the paper machine, but to avoid repetition only one such unit will be described. This spur shaft is coupled to a differential gear, the other end of the differential being coupled to a shaft, hereafter termed the "differential shaft," upon which is mounted a small cone pulley belt driven from a similar cone pulley mounted on the shaft of the main sectional motor. Belt guides are introduced to ensure that the belt, when once set, will not wander over the face of the pulleys. A diagram of this arrangement is given in Fig. 3.

The differential is surrounded by a stationary shunt regulator with a moving arm mounted on the differential case. This regulator controls the speed of the main sectional motor, being in circuit with it electrically in the usual manner.

Now, owing to this combination, if the spur shaft and the differential shaft are not running at the same speed, the case of the differential, and with it the attached shunt regulator arm, revolves. Immediately this happens the speed of the main sectional motor is altered, and instantly synchronism is effected between the spur shaft and the differential shaft through the medium of the belt connecting the two cone pulleys on motor and shaft respectively; the switch arm oscillating between two contacts until any further factors operate to change either the speed of the small master motor or the main sectional motor, in which event the shunt regulator arm will then simply move slightly into such a position relative to the shunt regulator as will ensure the same speed of the spur and differential shafts. The two shafts will then run in harmony at the same speed per minute, per hour and per day.

The cone pulleys are employed to give different drafts between the several sections of the paper machine, a speed change of 15 to 20 per cent. being generally provided. This change of draft is effected by means of a handle, suitably placed on the operating side of the paper machine, connected through a shaft on to the guide controlling the cone-pulley belt drive. The speed of the whole machine can be changed by altering the voltage of supply to all the motors, including the master motor. A simultaneous change of speed takes place, of course, in every sectional motor, the whole machine being the equivalent of mechanically inter-locked at the same draft. Once the belt connecting the two cone pulleys is set the draft so set will be maintained, regardless of any change of voltage, except as a whole as described, or of the mechanical conditions; the machine is locked with a fixed sectional draft relationship which will never change except at the will of the operator.

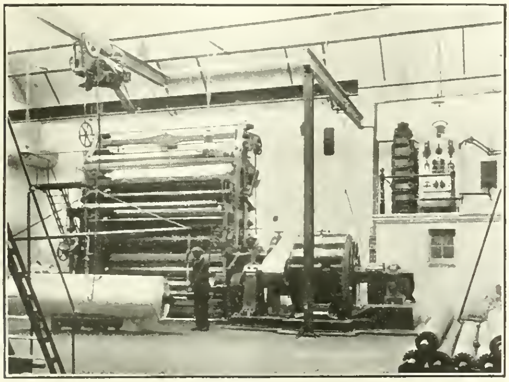

Fig. 4.—General View of Electrically Driven Super-Calender.

Such a system is well worthy of consideration, a few of the many advantages being: (*a*) Small amount of space taken up, (*b*) No necessity for basement, (*c*) Cleanliness of drive, (*d*) Absolute sectional speed harmony, (*e*) The entire absence of "broke," due to inequalities of drive. The fact that news machines, designed to run at 1,000 feet per minute, embracing the above-mentioned system, are being constructed, as well as a number of other installations for "tissue" and "fine printings" designed to run with a speed variation as much as 10 to 1, fully warrants the space given to its description.

The Super-Calendering Machine.

The manufactured paper has now to undergo the important process of super-calendering, this imparts a surface to the paper. It is here, perhaps, we meet with a unique example of the utilisation of electricity as a power agent in a paper mill, a full account of which is justified.

The system adopted is of the "push-button" type wherein the control is operated by means of push buttons which close magnetic "clapper" switches controlling a $\frac{1}{4}$ h.p. "pilot" motor operating, by means of a sprocket and chain drive, through wormed gearing to the main rheostat. Upon making connection across the initial contact studs of the main rheostat a 15 h.p. motor is "energised." This is geared down to the main 150 h.p. motor driving the super-calender by a chain. The 15 h.p. "auxiliary" motor runs at 1,000 revs. per min., driving the main motor at 100 revs.

Upon operating the push-button marked "speed up" the rheostat is traversed until the main motor is excited and assumes the load at approximately 400 revs. per min.; at the same time the auxiliary motor is "cut out" and stops. The speed of the main motor can then be increased as required to 850 revs. per min. This system of super-calendar drive has proved eminently successful, having the advantage of a great variety of speeds and rapid acceleration, these points being essential features. One of these machines is shown in Fig. 4.

Provision has been made for reducing the "bus-bar" load in the event of a breakdown or enforced reduction of the supply by introducing a system of signals between the main switchboard and the calender room whereby the 150 h.p. motor driving each super-calender can be stopped or the load reduced as circumstances require almost instantaneously without having to cut off the supply from the main switchboard, and thus putting the whole calendar room in darkness. The system comprises three illuminated signs fixed in a suitable position on the calender room wall and reading: "stop," "reduce load to 40 amps." and "full speed." These are controlled by three switches on the main switchboard, the required sign being illuminated and a bell rung simultaneously to draw the attention of the man in charge, who then rings a bell on the switchboard to signify receipt. This has proved most useful.

From the super-calenders the reels of paper are taken to the various reelers, cutters, guillotines, &c., which, as their names imply, cut and reel the paper to the required sizes. All of these machines are driven by electric motors employing a belt drive, having a large speed variation obtained through shunt regulation and controlled by multiple speed "Igranic" starters.

The finished paper is then either taken into the warehouse or despatched by rail. In each case electric hoists of the "chain block" type are used, power being supplied by a $2\frac{1}{2}$ h.p. motor series wound and controlled by a reversible drum controller. The whole is assembled and suspended from the under flange of an "H" section girder situated as required; trolley wires are strained either side of the girder about 12 in. from and parallel to the centre of the web. Collecting shoes are carried on insulating arms attached to the framework of the hoist sliding along the trolley wire with the travel. A view of the electrically driven reelers and hoists is shown in Fig. 5.

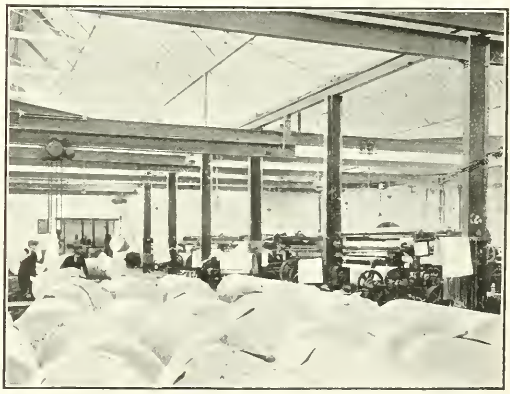

Fig. 5.—General View of Electrically Driven Reelers, Showing Electric Hoists used for Taking Paper to Stock Room or Rail.

Conclusion.

A few general remarks in summing up will complete the purpose of this article.

Approximately 250 motors are used varying from 150 h.p. to $\frac{1}{4}$ h.p. embodying all types of drive, direct coupled, belt driven, chain driven or geared according to the purpose for which they may be required. It has been found desirable in cases where motors of 40 h.p. and over are controlled by the ordinary starting panel, comprising D.P. switch and fuses, ammeter and starter, such motors being variable speed type are subject to momentary overload, to fit either a S.P. or D.P. circuit breaker in place of the usual fuses. This saves the expense and inconvenience of replacing the ordinary porcelain bases and fuse carriers.

Perhaps the bulk of these motors are used in driving pumps; their importance must not, however, be minimised by this fact, for, what the heart is in the human body so the pump is in a paper mill: the heart circulates the blood throughout the system, the pump circulates the water and "stuff" throughout the mill. The stoppage of either spells disaster.

The question of standardisation has not been touched upon, as, perhaps, it is obvious that such must be carried out wherever possible, thereby reducing spares to a minimum, and saving money, space and confusion.

As a final remark, it is not hard to foresee a great future for electricity in paper mills in this country, provided electrical engineers will adapt the power they possess to the problems confronting them. Above all things they must convince the paper manufacturer that they have something better and cheaper than he at present uses. There will then be no limit in this country to the application of electrical energy for power transmission in a paper mill.

Notes on Operating a By-Product Producer Gas Plant for Power and Heating.[*]

By W. H. PATCHELL.

Apart from three classical Papers by Mr. H. A. Humphrey,[†] there is little accessible information on this subject. An account of a modern by-product producer gas plant and accessories adopted as a result of an investigation for the Hoffmann Mfg. Company, Ltd., in 1915, may, therefore, be of interest. In view of the costs of coal and oil, the choice fell on a by-product recovery producer gas plant on the "Lymn" system. It was arranged to put down the plant in 30-ton units. The first unit was in operation in August, 1917, and the complete 60-ton plant has been in operation since March, 1919, but has not yet been worked up to its full capacity.

In the original Paper the author then outlines some of the chief points in the operation of a by-product recovery gas plant, which is supplied with air mixed with steam, which also plays an important part in the destruction of ammonia; from 2 lb. to 2½ lb. of steam per lb. of coal gasified is an average figure. The gases are cooled by contact with water, and the air is heated and saturated with the hot water so obtained. About 0·75 lb. of steam is thus picked up by the air for every pound of coal gasified, with a temperature of about 68 C. saturation. The balance of steam required, about 1·25 lb.—1·5 lb. per pound of coal gasified is blown into the saturated air, increasing the saturated temperature to 82 C.—84 C. A superheater was included as part of the boiler plant, and a regenerator is provided increasing the temperature of the air and steam mixture to about 220 C., and preventing the fuel load from falling below a good working temperature. In the original Paper a diagrammatic view of the "Lymn" system is included, and a description is given of various features of the plant, including the blowers, coal-conveyers, regenerator, washers and scrubbers, &c. Otto gas engines of 500 B.H.P. were used. For Messrs. Hoffman's works 270 units 360 kw. alternating-current machines were used. The efficiency of the dynamos is 92 per cent. on full load, 91 per cent. on three-quarter load, and 90·5 per cent. on half load.

The first table contains an analysis of the capital cost of the plant per kilowatt, of which the gas producer plant formed the chief item. The total cost for the first (1916) plant amounted to £40·98 per kilowatt, of the second (1917) plant £50 per kilowatt. Data on operating results are next presented, and are reproduced in Table II.

It will be noted that more steam is raised by the exhaust boilers than is required to make gas for the engines. About 130,000-140,000 cubic ft. of gas was made per ton of coal gasified, and an analysis of this gas is given. About 65 per cent. of the theoretical recovery of sulphate is recorded *i.e.*, about 90 lb. per week. Tests of the gas engines show respectively 93·57 and 102 cubic ft. of gas per kilowatt-hour for the engines and 13,062 and 13,759 therms per kilowatt-hour for the generators, the calorific value of the gas in therms per cubic feet being 139·6 and 134·79 respectively.

The general thermal efficiency on the units delivered to feeders is given as 19·9 per cent.

The data in Table II. regarding running costs are instructive :—

In the main the plant has worked very well. Careful inspection for possible corrosion has been made. It would appear that composition of coal is an important factor, and that when using mild steel plates little corrosion takes place, unless the metal is subject to either erosive action or is under stress. In this plant there has been no trouble experienced.

Reference is made to electrostatic gas cleaning, which, however, does not yet appear to have been used with producer gas, owing to deposits of tar on the electrodes, though very successful in the cement and smelting industries. In the concluding portion of the Paper a chart showing gas and air temperatures in the Lymn gas plant is presented

As regards general results, the values of 1·51 lb. of coal per unit and the general thermal efficiency of 19·9 per cent. on the units delivered to feeders compare favourably with corresponding data given by Mr. David Wilson for supply stations in this country; the best station in the Northumberland district showing 1·8 lb. per unit and 18 per cent. efficiency on units generated. The average for 438 stations was 3·46 lb. of coal per unit, and a thermal efficiency of about 9 per cent. The author is a believer in the future of large cylinder high power gas engines.

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[*] Abstract of a Paper read before the Institution of Electrical Engineers.

[†] "Mond Gas Producer Plant," Institution of Civil Engineers, 1897; "Power Gas and Large Gas Engines," Institution of Mechanical Engineers, 1900; "Generation and Distribution of Producer Gas in South Staffordshire," Institution of Civil Engineers, 1912.

Table I. —*Power-plant Coal Consumption.*

Coal gasified in producers.		Coal if 25 per cent. is required to provide steam.	Coal gasified plus coal for steam making.		Amount of coal saved.		Surplus steam used for manufacturing purposes.	Actual coal to be debited to power plant.		Load factor gas engines.	Overall electro-thermal efficiency.
Total.	Per kw.-hr.		Total.	Per kw.-hr.	By exhaust boilers.	By tar burnt.		Total.	Per kw.-hr.		
Tons.	lb.	Tons.	Tons.	lb.	Tons. 379·75	Tons. 114·7	Tons.	Tons.	lb.	Per cent.	Per cent.
1,390	1·7	347·5	1,737·5	2·12	494·45 tons		146·95	1,243·05	1·51	73·6	19·9

Table II. *Power-plant Running Costs per Kilowatt-hour, Six Months, 1918. Including Credit for Sale of Sulphate of Ammonia and Debiting Cost of Sulphuric Acid.*

Average price of coal	£1 8 11 per ton.
Average price of sulphuric acid	4 13 0 ,,
Average price of sulphate of ammonia	17 2 0 ,,

Units from switchboard.	Fuel.	Lubrication.	Supervision and labour.	Repairs and renewals.	Charges on capital, 10 p.c.	Total.	Load factor.
1,834,375	0·166d.	0·058d.	0·159d.	0·130d.	0·207d.	0·720d.	73·6 p.c.

DISCUSSION.

Mr. C. Percy Taylor said stress was rightly laid on the importance of the steam supply, which made the difference between success and failure. There were one or two figures given by the author that did not seem to agree. The cost table would be better if split up more. It would be better if the gross cost of coal were given, and the saving made on the sulphate shown. It was important to consider whether it paid to recover the sulphate or not. With coal at 28s. 11d., fuel instead of being 0·166d. was 0·263d. Renewals and repairs were rather high, considering that the plant was new. The efficiency of the producer worked out at 79·3 per cent., which was too good. Bone and Wheeler had stated that between 60°C. and 80°C. and the thermal efficiency of the producers was 80 per cent. at 60° saturation, and fell to 76 per cent. when the saturation rose to 80°.

Dr. Morley said the paragraph in Mr. Fowles' Paper referring to the present waste of fuel should be learnt by heart. But Mr. Fowles might have made out a better case. He found that neither the horizontal slow nor the vertical high speed gas engine gave him any trouble. But the large horizontal engine was considered usually preferable to the multi-cylinder vertical engine, because of its greater simplicity and accessibility and freedom from breakdown. It would have added to the value of the Paper if some figures with regard to maintenance costs had been given. The objection was sometimes raised that the pistons of large gas engines had to be water-cooled. In the large Galloway engine described by Mr. Fowles there was only one water connection on a moving part. Even up to the largest sizes cooling of the exhaust valve could be dispensed with. Makers of large vertical gas engines relied on mechanically-operated valves, which lifted at a fixed point on the stroke.

Mr. W. B. Woodhouse understood that Mr. Patchell's problem was not to supply only power, but also heat, and he gathered that if he had wanted to supply power only he would have put in a producer plant with a gas engine. There might have been a case for that when coal was at 5s., but it was a different problem to-day. With a thermal efficiency of 70 per cent., 30 per cent. of the heat was thrown away, and the capital charges and maintenance and labour had to be made up by the sale of sulphate. Taking the value of the latter as 10s. per ton of coal put into the producer, and putting on the other side 30 per cent. of the cost of coal, which at 30s. a ton was 9s., and 1s. was left to pay for all those other charges. There was no case for a by-product producer raising gas for power alone, and the producer plant was worse off now than it was when coal was cheap. To be efficient a gas engine must be run on a high load factor. With a large steam turbine the initial consumption was between 15 and 20 per cent., and in Mr. Patchell's engine it was 66 per cent. It would not pay to run such an engine on a 10 per cent. load factor. Mr. Fowles' comparison of blast furnace plants with electricity stations was fallacious. The position as regarded the ironmasters was not so bad as Mr. Fowles would have them believe. In practically all the large works the ironmasters concentrated their steel plants round the blast furnaces, and utilised as much heat as possible, and if they had any surplus they sold it to a public supply system as electrical energy. Gas could be cleaned in other ways than that adopted on that particular German plant. He (the speaker) put up some years ago a small power station to use gas as boiler fuel and produce electrical energy by means of a small turbine. The efficiency ratio of the turbine was only 50 per cent., and the over-all thermal efficiency of the station was 14 per cent. If the steam plant had been on a larger scale it would have been possible to get a turbine with an efficiency of 70 per cent. If 30 per cent. was to be got by simply using a gas engine that was an engine he knew nothing about.

Capt. A. P. Pyne said the thermal efficiency quoted by Mr. Patchell could be considerably higher with a large gas power station. Mr. Fowles' figures in regard to the utilisation of blast furnace gas were on the optimistic side; but Mr. Woodhouse was very wide of the mark in saying blast furnace gas was being fully utilised in this country. In Germany, in one district partly in the occupied territories, every small, blast furnace had its gas engine, while in one case blast furnace gas was supplying the whole needs of a large shipyard. Prior to 1914, no up-to-date gas plant existed in this country.

Mr. H. J. Gibbons said the figures Mr. Patchell had given showed that it was possible to produce power at a price which compared favourably with the charges of electric supply undertakings. But the repairs costs and the capital costs seemed rather high. Multi-cylinder engines with their slower speed generator were cheaper in capital cost than the high-speed vertical with its cheaper generator. There should be more co-operation between electricity undertakings and ironworks in this matter. The utilisation of gas had not been sufficiently wide.

Mr. J. Paton said the gas engine proposition was not so favourable as it was before the war. He thought the Moore producer was on the right lines. With that, 60 per cent. of the nitrogen and fuel was recovered, and with one he had obtained a fuel consumption of 10·6 lb. per kilowatt-hour, which was less than Mr. Patchell quoted.

Dr. J. A. Harker said the report of the Nitrogen Products Committee, published in January,* dealt with this subject in a way electrical engineers would find useful. Many of Mr. Patchell's conclusions were in strict agreement with the views of that Committee.

Mr. A. Bass (Hoffman Mfg. Company) said, after running their gas engine plant two years and eight months, the company were satisfied as to its efficiency. There was no reason why, both in size and reliability, the gas engine should be regarded as behind the steam engine for straightforward work, such as driving an electric generator.

Mr. A. H. Lymn said he believed if the plant at the Hoffman works were used continuously they would not be behind the other figures in regard to the recovery of steam. Mr. Woodhouse said when coal was dear was not the time to put in gas engines. They had to face the fact that steam could be raised in various ways; in conjunction with furnace plant, from the waste gases of the oven furnace, by means of the exhaust gases, and by using non-condensing plant. He agreed with Mr. Patchell that the gas turbine was not a commercial problem; but Messrs. Thyssen, of Mulheim, had building or under consideration two turbines of 500 H.P. and 1,200 H.P. These were to be built with horizontal shafts.

Mr. H. Chaney endorsed Mr. Patchell's figures of the economy in the production of electricity. In a problem he had to work out he intercepted the high-pressure steam as it came from the boilers, generated his electric energy with it, and passed on the exhaust steam for the manufacture of producer gas. He found he could dilute the coal used in the producer with refuse fuel, such as coke dust.

Mr. J. H. Preece did not understand Mr. Fowles' attitude to the question of firing boilers with gas. He (the speaker) did not argue it was bad policy. The trouble with gas firing had always been uncleaned gas. But he thought they would soon have clean gas, and then they should get 78 per cent. efficiency.

Mr. Leonard Andrews said one of the points he had tried to make in a Paper read 11 years ago was the higher the cost of coal the greater the saving that could be effected by gas engines. The one thing gained by the use of gas engines was the saving of coal.

Mr. H. M. Ridge said the plant described by Mr. Fowles had water in direct contact with the gas for pre-cooling. It was undesirable to increase the humidity of the gas. The average temperature of the blast furnace was between 250 C. and 300 C., which had to be cooled down to 110 and probably 100. A number of blast furnace works used coal under their boilers because the gas was so dirty.

The President announced that the authors would reply to the discussion in writing.

The Production of Power From Blast Furnace Gas.*

By S. H. FOWLES.

Sir Charles A. Parsons has estimated that the total available water-power in the British Isles is only 1½ million horse-power, and that England possesses only 1 per cent. of the water-power and 2½ per cent. of the total coal, in the world. At present about one million horse-power are being wasted from the blast furnaces of this country. The author estimates that by the efficient treatment of only three blast furnaces an additional 10,000 H.P. could be produced and 5–6,000 H.P. saved in coal, making a total saving of about 16,000 H.P.

The gas is a by-product, and has in the past been regarded as of little value, being either wasted or used very inefficiently. Gas produced from coke, limestone and ore during smelting was originally blown into the atmosphere as waste. It was afterwards used in a crude manner for steam raising. Later still, vertical stoves were designed to heat the blast until the firebrick lining was raised to 700–800 C. A marked saving in the use of coke was thus effected by this practice, which was common up to 1913, 40 per cent. of gas being used for the hot stoves and 60 per cent. for boiler firing; 80 tons of coal per week were also used for the boilers on one furnace. Flues were, however, always in a clogged state; boiler tubes also became coated with dust, and the efficiency was low.

On the old method, with 1 million cubic feet of gas made per hour, 0·4 million was used on the hot stoves and 0·6 million on boilers. In addition, coal used per furnace per hour amount to 0·5 ton, the furnace blowing arrangement averaged about 600 H.P., and the total therms employed was estimated at about 75 million. This number of therms, used in gas engines to-day, would develop 6,500 H.P., so that the efficiency is about 10 per cent. as compared with present-day gas-driven plant.

On the new methods, for 1 million cubic feet of gas made per hour, 0·4 million cubic feet would be used in hot stoves, and one used on boilers; 0·15 million per furnace in the blowers, so that the total gas used per furnace is 0·55 million cubic feet. The furnace-blowing, owing to increased production with higher stove temperature on clean and dry gas, will be 800 H.P. The total therms involved is approximately 20 million. The remaining unused 450,000 cubic ft. of gas available per furnace for other purposes is equivalent to about 3,000 units of electricity per furnace per hour. Thus, with 50 such furnaces, over 1,000 million units would be saved per annum, which, with the boiler saving, leads to a saving of 400,000 tons of coal per annum. The electrical energy saved is thus almost the same as the total number of units sold by the 303 electricity works in the United Kingdom during 1911-1912.

The author, in the original Paper, then proceeds to discuss in some detail the merits of different kinds of plant, referring to the Hallberg-Beth type, which has several advantages, notably the recovery of the bulk of the potash in its original state, the low dust contents (0·002 gramme per cubic metre), the ease with which moisture can be removed or allowed to remain at will, and the fact that the plant can be worked for long periods up to 30 per cent. overload.

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* *See* The Electrician, Vol. LXXXIV., p. 82, January 23, 1920.

* Abstract of a Paper read before the Institution of Electrical Engineers.

The total moisture content (15 grammes per cubic metre) is also very low.

The plant consists of three filter units of 11 double compartments each, with a total nominal capacity of 3·3 million cubic feet of gas per hour, and is provided with fans of a nominal capacity of 4 million cubic feet of gas per hour.

The guaranteed horse-power consumption when dealing with 2·75 million cubic feet of gas per hour at a delivery pressure of 2 in. (water gauge) is 150 H.P.; with 4 in. pressure 180 H.P. Similar figures for 3 million cubic feet of gas per hour are 180 H.P. and 210 H.P. at the pressures named above.

The actual consumption on the plant described when dealing with 1·35 million cubic feet of gas per hour at a delivery pressure of 4½ in. (water gauge) is 95 H.P. The motors are direct current, shunt wound, interpole, 500 volts, 160 B.H.P. machines run at 900 revs. per min

The engines for generation comprise seven sets of 12-cylinder tandem vertical 1,500 H.P. direct coupled to 1,000 kw. three-phase alternators running at 200 revs. per min., and are run in parallel with a public electric supply at 5,500 volts.

The total area of filtering medium is 16,632 sq. ft., and 5 per cent. of this is automatically shut off every 10 minutes for shaking and cleaning. The dust which is recovered from the cleaning of the gas is about 50 tons per week, and is equal in potassium chloride to about 30 per cent.

The general operation of the plant is as follows:

The crude gas is first cooled in the pre-coolers and lowered in temperature from about 200 C. to 80 C., a large amount of dust and moisture being deposited. It is then heated up about 10 C. or 15 C. to allow of the gas passing through the plant, with its moisture contents superheated, and not to be influenced by the surrounding atmosphere, which is liable to deposit moisture and so clog up the filter bags. The gas then-passes the filter bags where it is cleaned and its dust removed, afterwards passing to the mains fans, and is finally delivered by them to the respective places for consumption.

Immediately above the main fans, and on the suction side, a main is taken out to supply the counterblast fan, which delivers a quantity of cleaned gas continuously through a re-heater to the clean side of the bags in the compartments only that are open for cleaning and shaking. During this operation the shaking gear operates a double-way valve, thus cutting off the main fan suction from that particular compartment and opening the path for the clean counterblast gas, which is at a pressure of a few inches (water gauge) above the pressure at the pre-heater bottom. The counterblast flows through the bags, takes the dust from the inside and passes on with the gas to be cleaned.

The plants work continuously and have a very low upkeep and operation cost, which the author tabulates in an appendix.

The following two tables are of interest, and the author calculates the net saving per annum on the new method as compared with the old to amount to £109,353.

BALANCE SHEET OF OLD AND NEW METHODS.

——	Old method.	New method.
Gas made per furnace per hour	1,000,000 c. ft.	1,000,000 c. ft.
Furnace rate of working	Normal	10% increase
Coke per ton of pig iron made	23 cwt.	21 cwt.
Units of electricity generated per furnace per annum	Nil	6,870,000
Potash saved per annum	Nil	£6,000
Flue-cleaning costs per annum............	£1,000	Nil
Coal used per furnace per hour............	0·5 ton	0·2 ton
Horse-power developed per furnace per hour..	600	800
Therms used per furnace per hour	74,560,000	20,824,000
Gas used per furnace per hour	1,000,000 c. ft.	550,000 c. ft.

Comparison of 303 Electricity Works and the Estimated Waste Gases of Great Britain's 50 Blast Furnace Plants.

303 electricity works.	1911–12.	50 blast furnaces.
Capital expenditure	£63,788,732	£10,000,000
Total revenue from all sources............	£8,675,900	£8,195,750
Working expenses	£4,086,704	£2,730,600
Gross profit....................................	£4,589,196	...
Net profit	£2,880,939	£5,465,150
Number of units sold........................	1,127,499,742	1,030,540,000
Working costs per unit	0·87d.	0·3d.
Plant capacity in kilowatts	961,520	565,000
Capital per kilowatt of plant capacity...	£67	£17·7

Earthing the Neutral of Generating and Transmitting Systems.*

By H. R. WOODROW.

6,600-volt 25-cycle System.—It had been the policy of the New York Edison Company to operate its high-tension feeders radially with the system neutral unearthed, but with selective earth indicating relays on all feeders to locate a ground on any feeder. This method of operation gave the operators time to disconnect defective earthed feeders from the system before developing into short circuits, and as a result 70 to 80 per cent. of the system earth failures were cleared in this way. During the later years, however, it became desirable to study means of paralleling feeders at the sub-stations and of reducing the time limit for disconnecting the defective feeder to avoid short circuits following an earth on account of the increased capacity current of the greatly larger mileage of cables on the system. After a careful analysis it was decided to establish a definite earth current by means of earth transformers connected to the system bus bar and connect the selective earth relays to trip the oil circuit breakers automatically.

The method of earthing through zig-zag-connected transformers was adopted as the latest generators installed are delta-connected. The limiting resistances were connected on the primary side of the earthing transformer and of a value to limit the total earth current with both generating stations operating in parallel to 400 amperes. The selective earth relays, which are operated from sheath type current transformers, are adjusted for operation at 140 amperes minimum and at 300 amperes in 1 second.

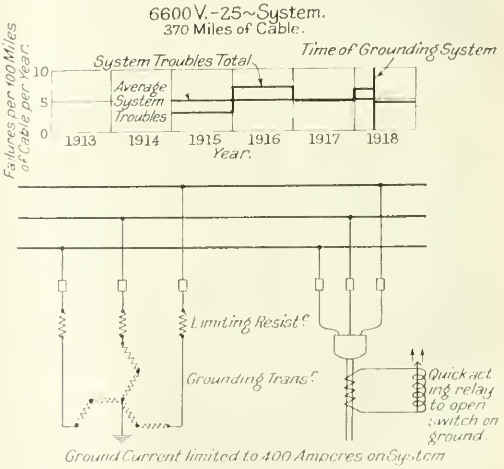

FIG. 1.

The above described system was placed in operation in the early part of 1918, and Fig. 1 shows the results which have been obtained. Although the time that this system has been earthed is too limited to draw any definite conclusion, the total system troubles have slightly decreased, and of these total troubles the number which have developed into short circuits is reduced to 60 per cent. of those before earthing.

7,800-volt 60-cycle System.—The new 201st-street station of the United Electric Light & Power Company was placed in service with the same general scheme of operating. In the first few years of operation, however, several generator failures were experienced, and on the recommendation of the manufacturer the system was earthed by means of the generator neutral through a two-ohm resistance, which would allow an earth current of approximately 2,000 amperes to flow. The results of the system troubles before and after earthing are shown in Fig. 2, and there has been an apparent reduction in the number of system troubles since.

16,000-volt System.—When the 16,000-volt system was adopted step-up and step-down transformers were provided on each feeder, thereby isolating the high-tension side of each feeder. During the first two years of operation the number of cable failures was very large, most of which occurred in the cable joints. To remedy this trouble a number of joints on the 60-cycle system were changed, and the transformer connections were altered to make a solid earth on the high-tension side. The systems were operated in this manner for a period of approximately two years, and no material change in the number of failures occurred. During this time, every earth on the system was a short circuit, due to the solidly connected neutral, thereby materially increasing the stresses on the transformers and cables. It was decided to change the method of earthing, and provide quick-acting relays to disconnect a feeder practically instantaneously on an earth. The method adopted for earthing these feeders is shown in Fig. 3. In the year and a half that this system has been in operation, the results have been encouraging, although the number of system troubles was only reduced by approximately 28 per cent. : the number of short circuits have been reduced by 82 per cent. In 73 per cent. of the cases in the present method of operation the failures are disconnected from the system before short circuit occurs.

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* Abstract of a Paper read before the American Institute of Electrical Engineers.

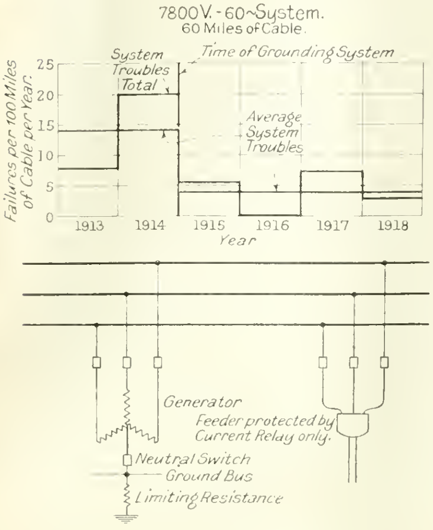


FIG. 2.

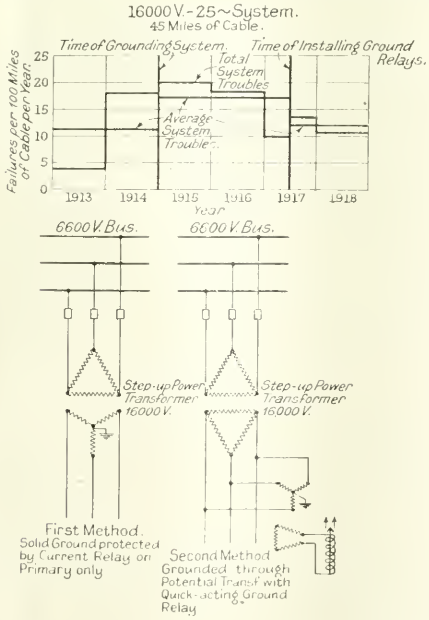

16000V. - 25~System.
45 Miles of Cable.
Time of Grounding System.
Time of Installing Ground Relays.
Total System Troubles
Average System Trouble
Failures per 100 Miles of Cable per Year.
0
5
10
15
20
25
1913
1914
1915
1916
1917
1918
Year
6600V. Bus.
6600V. Bus.
Step-up Power Transformer 16000V.
Step-up Power Transformer 16000V.
First Method. Solid Ground protected by Current Relay on Primary only
Second Method Grounded through Potential Transf with Quick-acting Ground Relay

FIG. 3.

25,000-volt 25-cycle System. In the installation of 25,000-volt 25-cycle cables, the neutral of the transformers at the generator end was solidly earthed. The type of joint used in this cable was of the oil-filled type and practically no failures have resulted in the joints. In the first 15 months of operation, however, a number of cable failures occurred, some of which could be traced to defective manufacture of cable. To relieve the stresses on these cables it was decided to install earthing relays connected to a sheath transformer for disconnecting the cable very quickly on an earth, as the method of operation of these feeders necessitated a long time setting on the normal current relays. These cables have been in operation with this method of protection for three years and, as shown in Fig. 4, the number of failures has decreased until no failures have occurred during the past year.

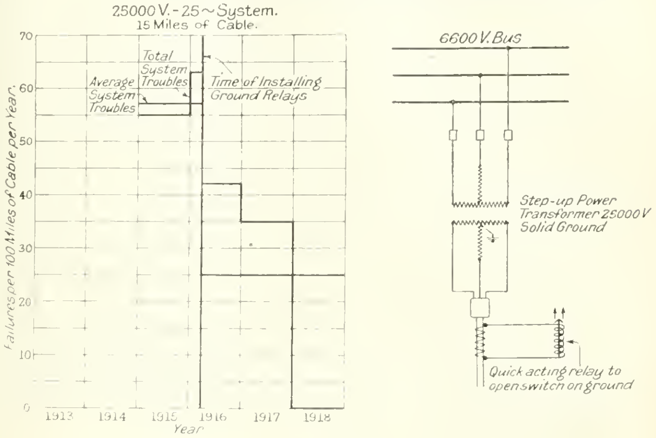

25000 V. - 25 ~ System.
15 Miles of Cable.
Total System Troubles
Average System Troubles
Time of Installing Ground Relays
Failures per 100 Miles of Cable per Year.
0
10
20
30
40
50
60
70
1913
1914
1915
1916
1917
1918
Year
6600 V. Bus
Step-up Power Transformer 25000 V Solid Ground
Quick acting relay to open switch on ground

FIG. 4.

Experience has shown unquestionably that the stresses on the cables are relieved materially by earthing, but it is believed that it is desirable to limit the earthing current as much as possible, thereby reducing the stresses on the system, and particularly the burning of the lead sheath and earthing connections. The installation of earthing relays, which can be set to disconnect a feeder more quickly than the straight normal current relays, will further greatly relieve the potential stresses due to a prolonged earthing current which occur even with an earthing system.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Mathematical Tables." By W. E. Dommett and H. C. Hird. (London : James Selwyn & Company, Ltd.) Pp. 78.

"Labour Difficulties and Suggested Solutions." By W. J. Deeley, B.A., 2nd Edition. (London : Benn Brothers, Ltd.) Pp. x.+228. 11s. net.

"Romance of a Great Factory." By C. M. Ripley, E.E. (New York : The Gazette Press.) Pp. 204. $2·00.

"A Text Book on Machine Drawing for Electrical Engineers. Forming an Introductory Treatise on the Construction of Electrical Machinery and Apparatus," by E. Blythe, A.M.I.Mech.E. (London : Cambridge University Press.) Pp. vii.+81. 21s. net.

"Silvanus P. Thompson, D.Sc., LL.D., F.R.S., His Life and Letters," by J. S. Thompson and H. G. Thompson, B.Sc. (London : T. Fisher Unwin.) Pp. ix.+372. 21s. net.

"Collected Scientific Papers," by J. H. Poynting. (London : Cambridge University Press.) Pp. xxxii.+768. 37s. 6d. net.

"Fuel Production and Utilisation," by H. S. Taylor, D.Sc. (London : Baillière Tindall & Cox.) Pp. xiv.+297. 10s. 6d. net.

"Cours Pratique d'Electricité Industrielle," by H. Chevalier. (Paris Librarie Polytechnique Ch. Beranger.) Pp. 403. 24 frs.

"Electricity : Its Production and Applications," by R. E. Neale, B.Sc. (London : Sir Isaac Pitman & Sons.) Pp. viii.+136. 2s. 6d. net.

Heating and Cooking Notes.

The Design of Cookers.

Originally there were two main classes of cooker design, the unlagged sheet metal oven and the lagged cast iron type, resembling a gas stove. The present tendencies seem to be toward a cooker made of sheet metal built upon a cast-iron frame and lagged. This method certainly offers opportunities for cheap construction, though there is the accompanying risk of the work being cheap and nasty. If the modern housewife does not exactly want to be able to turn a hose on to the oven, she does desire to keep it reasonably clean, and sharp corners angles, ridges, &c., do not tend toward this end. If she cannot clean it, she will condemn the apparatus as "smelly" even if it isn't. Given a demand for cookers in reasonable quantities, the cost of the necessary press tools to make a decent job of the sheet metal frame are not prohibitive in cost per cooker; and there is evidence that a reasonable demand does exist both in this country and in the colonies.

Another factor in connection with cleanliness lies in the use of sheet iron with a blue-black surface. Unless the user is willing frequently to clean such a surface, the inevitable result will be rust. Adequate cleaning then becomes impossible, the appearance of the cooker deteriorates and the whole appliance is well on the way toward scrap. The employment of enamelled iron would add to the appearance of the cooker, facilitate cleaning and generally promote an attractive atmosphere. Nickel plating and enamel may seem useless trimmings to an engineer, but the housewife, who in the end decides the destiny of household cooking appliances, is the person to be satisfied. If we intend to live up to the advantage of cleanliness claimed on behalf of electricity, easily removable elements, which slide out as a complete section in the form of a grid or tray, so that oven interior can be left bare for cleaning, are a feature that has to be developed. There seems to be some prejudice against the use of plug connections and in favour of bolts and nuts though the former are far simpler, and the latter invariably "rust up" and give great trouble when repairs are necessary.

Because kitcheners and gas cookers have ovens low down is no adequate reason why electric ovens should follow suit. Bending may be good for the corset manufacturer, but it is far better for electrical engineers to be able to claim that the electric cooker obviates stooping. Building the oven to a convenient height by the use of suitable legs is a distinct advantage. There is no necessity for the range to be on top of the oven unless the cooker has to occupy a very cramped space. By arranging the cooker with a hot closet at the top of the oven, and a range at the side, comfort and convenience in cooking are gained. The hob should not be too small, as this only means spilling and difficulty in moving the utensils. Neither should the hob or range top be as high as the top of the oven. Potato saucepans and similar articles are heavy and awkward to lift above waist level. The old coal range had to be compact because there was only one source of heat: but that is not so with the electric cooker, because the hot plates, oven, grill and hob can all be used separately and independently. We claim that electric cooking is convenient; why not, therefore, design the apparatus so that it offers the greatest ease and convenience in use.

There is much to be said in favour of the level hob plate with hot-plate elements beneath, as against the use of a hob plate pierced to allow the hot plates to come through. The former offers an easy means of handling a number of utensils on the hob, whilst the latter often leads to spilling and the tendency to try to divide the heat from the plate between two utensils. Then, if the hot-plate surface is not exactly level with the hob plate, the resultant loss occurs due to bad thermal contact. Cooker design requires to be carried out quite as much from the cook's view point as from the factory view point. Hitherto the latter has rather tended to predominate.

The Energy Consumption Value of Lamp-holder Appliances.

Not only do the various small household appliances, such as irons, toasters, &c., offer a most suitable means of introducing larger appliances into the homes of consumers and gaining their confidence in electrical methods, but they are also of value from the energy consumption view point. It must be remembered that in many cases such apparatus is used from a lamp-holder, and the energy used is charged for at lighting rates. Whilst the cost is not prohibitive to the consumer in the aggregate, the revenue is of value to the supply authority. Further, such appliances give but little trouble in use, and therefore can be recommended with confidence. As modern appliances of convenience, and to a certain extent as novelties, they appeal to visitors who enter the consumer's house, and are, therefore, silent salesmen or advertisements for the use of electricity.

A 5 lb. electric iron, consuming, say, 400 watts, will be used, perhaps, once a week for a period of four hours, an annual consumption of 83 units.

The toaster only consumes 200 watts, but it may be used for both breakfast and tea. Taking 20 minutes a day as an average, and assuming it is used 300 days in the year, the resulting annual consumption will be 20 units. A kettle, consumption 600 watts, capacity 2 pints, used, say, only for early morning tea or water, will, on the basis of 15 minutes per day, give an annual consumption of 45 units, after allowing 65 days for non use, whilst the probability is that the kettle will on the average be used more often than once per day, and the consumption given above exceeded. On the same basis, a shaving pot will consume 15 units in a year, and a fan used only during 60 days for two hours a day will give the same annual consumption.

In view of the satisfactory nature of these appliances, it is quite possible, by making the necessary effort, to induce a householder to purchase a complete set. Six such appliances will yield an average consumption of 200 units per annum, which, at 6d. per unit, means a revenue of £5.

On the average, lighting consumption is between 300 and 400 units per annum, so that the effect of pushing the use of such apparatus is to increase the lighting revenue by 50 to 75 per cent. Taking a mean at 66 per cent., it means that on the average every lamp-holder appliance that is sold should yield an increased revenue of 10 per cent. on the lighting bill. The majority of such appliances would not be used during the "peak," and therefore this additional load can be obtained without creating any mains difficulty.

The electrical energy is available, the apparatus is available, therefore all that is required is effort on the part of supply authorities and contractors to push the sale and use of this type of electrical appliance.

Reviews.

Text Book of Wireless Telegraphy. By Rupert Stanley, B.A., M.I.E.E. London: Longmans, Green & Company). New Edition Vol. I. Pp. xiii.+471. Vol. II. Pp. ix.+357. 15s. net each.

Major Stanley's text-book, which is already well known, has now been printed in a new edition consisting of two volumes. The first volume, consisting of 471 pages and 255 diagrams, deals with the general theory and practice of wireless telegraphy. This volume has been brought up to date, new diagrams have been added and also a new chapter on secondary cells. This volume stands almost alone in its class and has adequately fulfilled its objects. One of its chief merits is that it is also a text-book of electricity for wireless students and one based on the electron theory.

The second volume is an entirely new one and deals with valves and valve apparatus. It contains 357 pages of concentrated information and 227 diagrams. It is a book which should be in the hands of every wireless student, amateur and engineer. Up till now no other book has presented in such detail modern wireless progress.

The first chapter gives an interesting account of the electron theory in considerable detail. Chapter ii. deals with the theory of the hard valve. Chapter iii. describes valve detectors and relays; while Chapter iv. is an introduction to high-frequency amplifiers. Chapter v. discusses the oscillating valve from a descriptive and mathematical point of view. Chapter vi. is a valuable account of low-frequency amplifiers, and diagrams of several French types are given. Chapter vii. describes some types of high-frequency amplifiers, including resistance amplifiers. Chapter viii. considers the theoretical aspects of heterodyne reception. Chapter ix. is a study of the characteristics of a French valve and gives much valuable information, although the effects of grid currents do not appear to receive the attention due to them. The next chapter deals with the characteristic curves of different types of other valves. To the valve designer this chapter will have a certain appeal, but owing to various changes in design, it will probably be soon out of date. Chapter xi. deals briefly with the dynatron and the valve as a limiter. Subsequent chapters (to a total of 17) deal with C.W. transmission and reception, wireless tele phony, earth current signalling and miscellaneous valve apparatus.

In a volume of this kind, which so excellently describes the most modern development in such detail, one hesitates before criticising individual portions. Many reviews are spoilt by petty criticism of details. The following remarks should be given the small relative importance appropriate to them. There is throughout the book a certain vagueness when the author discusses the potential drop across the filament. He commences by considering (Fig. 6) that the positive end possesses zero potential and that the negative end has a negative voltage equivalent to the voltage across the filament, which he always takes as being 4 volts. If the grid is connected through the grid circuit to the negative end of the filament, he considers that the grid is at -4 volts. This convention is very awkward. For example, let us take the case when the grid is connected to the positive side of the filament. It is considered as being at zero potential and one would not expect the considerable electron flow to the grid which takes place. If, however, we call the positive end $+4$ volts, we can more readily understand the presence of the grid current. It has been tacitly agreed to consider the negative end of the filament as having zero potential and to measure all other potentials relative to this point, and not to any absolute zero. On page 27 he states the valve functions at a point A (Fig. 6) when used as a relay. This point actually corresponds to $+4$ volts on the grid (*i.e.*, with respect to the negative end of the filament) and a grid current of 0·25 milliamperes. This is a most unsuitable point for amplification owing to the damping effect of the grid current. The mere fact of earthing the grid does not alter its potential with respect to the filament. Further on the author suggests that the higher the plate voltage the steeper the plate current curve. This is not generally the case and his own Fig. 8 shows this. In connection with rectification, the author, like many other writers, always specifies a distinctive bend in a curve. The student often finds that the *apparent* bend is not the most suitable operating point. It should be urged that rectification will take place at any point on a convex or concave curve, even when the curve is uniform. Grid current rectification, although the more common, receives scant attention, and no curves are put forward to explain the action.

In Fig. 9 the insertion of the grid potentiometer between the A.T.I. and the grid is likely to lessen the high-frequency potentials applied to the grid. For practical purposes it would be preferable to connect it near the filament side. In discussing the use of the upper and lower bends of the plate current curve for detection, the author somewhat underrates the value of the saturation bend for rectification purposes, as compared with the lower bend. This is unexpected when one remembers that several commercial detectors are designed to operate at saturation point, and also that one of the latest service detector-amplifiers is so designed. The suggested disadvantage of a grid current does not apply since the current is easily eliminated. It is, however, rather an advantage, since the grid current rectification effect acts in the same direction as the plate current rectification at the saturation bend. On the other hand, at the lower bend any grid current rectification would act in opposition.

On page 41 the author discusses the action of a grid condenser. His explanations are not altogether correct. In Fig. 14 two circuits are shown. One shows an aerial, an A.T.I. and an earth. The top of the A.T.I. is connected through a grid condenser (without leak) to the grid of a valve. The earth end of the A.T.I. is connected to the negative end of the filament. Telephones and plate battery are connected as usual. Major Stanley suggests that the grid now has a zero potential. Even this is not strictly true. The potential of the grid will be equal to that potential which, if applied to the grid with the condenser shorted, would give a zero grid current. This potential is usually in the neighbourhood of -1 volt, but may have any value positive or negative. The second circuit differs in that a variable condenser is included in the earth lead, and the connection from the bottom end of the A.T.I. is now taken to the positive side of the filament.

Major Stanley now changes his previous convention and considers that the middle point of the filament is at zero potential, the negative end at -2 volts, and the positive end at $+2$ volts. He now suggests that the left-hand side of the grid condenser has a potential of $+2$ volts and the right-hand side (and, therefore, the grid) a potential of -2 volts by electrostatic induction. As a matter of fact, electrostatic induction plays no part in determining the normal grid potential. A battery of 50 volts included in the grid circuit to the left of the grid condenser would not affect the steady grid potential. The initial potential of the grid is simply due to the accumulation of ions (usually electrons) on the grid, and its value will be equal to that which would give a zero grid current if the condenser were shorted.

Fig. 15 is intended to demonstrate graphically the action of a grid condenser. The normal grid potential gradually falls until the maximum amplitude of the wave-train is reached and rises to zero again at the completion of the wave-train. If this actually happened, grid condenser rectification would lose its chief advantage. Theoretically, assuming no leakage, the normal grid potential falls to maximum negative value and remains at that value, or almost that value, even past the end of the wave-train. This is true even for a considerable leakage. Since the grid potential has to be restored to its original value before the beginning of the next wave-train a grid leak is provided through which the negative charge leaks away. The potential of the grid should be restored to its original value just before the commencement of the next wave-train. The efficiency of grid condenser rectification lies chiefly in the fact that the plate current is kept decreased for a considerable period, which is much longer than the duration of the wave-train. The figure, as it stands, is more misleading than instructive. Fig. 85 of the same volume is the correct figure. An analogy is given which, unfortunately, contains a misplacement of one of the letters and which would have been clearer if it had described the increase of negative charge rather than the decrease of positive charge.

On page 49 the author recommends that the positive pole of the plate battery should be connected to the plate, any auxiliary circuit being connected between the negative pole and the filament. If this advice were followed there would always be a large capacity effect across the auxiliary circuit, which would greatly lessen the potential effect, not to mention the leakage which would be liable to result. The effect would be very serious in a resistance amplifier. The rule applies when only a telephone transformer or pair of phones are in the plate circuit. Fig. 26 is a case where the rule has been applied with disadvantage, while Fig. 25 is a case where it should have been applied.

In Fig. 28 the plate battery has been reversed. Fig. 30 shows an aperiodic "reaction" coil in series with a plate circuit inductance, which is shunted by a variable condenser. It is better practice in such circuits to connect the variable capacity across the *whole* of the inductance in the circuit. On page 89 the author states that the plate current of an oscillating valve should be varied between zero and the "extreme saturation value." The word "extreme" seems unnecessary emphasis, since if the representative point travels beyond the limits of the straight portion of the curve harmonics are liable to be produced. Fig. 144 has been incorrectly drawn. Fig. 151 has a connection missing. With reference to Fig. 163, the condenser *K* is not connected across the transformer winding in the plate circuit of the first valve but in an ineffectual position.

It might have been desirable in a book of this kind, which is written for all classes of workers, to give references to papers, patents and other sources of more detailed information. The present volume gives practically none. The serious student, and the more advanced readers, are consequently not encouraged to go further into the subject. Full references to other investigators and their work would in no way render the book liable to be considered merely a résumé.

During the war most wireless men did not have access to the chief original sources of information, but depended for their knowledge on retailed data. Consequently, the retailer usually gained more credit than the original investigator, and much obscurely published information was passed on as confidential. Now the doors have been thrown open and students of the science are desirous to know the real inventors and real originators. This volume would have been an excellent opportunity for satisfying their wishes. The volume as a whole is an important addition to wireless literature, and Major Stanley is to be thanked for the great amount of work which he has put into his book which will, undoubtedly, achieve a signal success.

John Scott-Taggart.

Silvanus Phillips Thompson, D.Sc., LL.D., F.R.S.; His Life and Letters. By J. S. Thompson and H. G. Thompson, B.Sc. (London: T. Fisher Unwin.) Pp. ix. + 372. 21s. net.

This book is at once a delight and a disappointment. The former because in it we may explore the doings of one who was a master of his profession, a teacher of men and a pure spirit; and the latter because we feel there is just a little something lacking in what it tells us about the man. Biography is a very difficult art, so difficult that the perfect biography has never been written, while even the number of first-class works is exceedingly small. A book like this, lovingly put together by wife and daughter, suffers under the same disabilities as an autobiography—a lack of detachment from the subject, a tendency towards myopia when criticism is necessary, and a desire to explain. This book has all these faults, and the further inevitable one, in a work published so soon after the death of the subject, that it does not enable us to place his work in its true relation to that of other workers in the same fields. It shows, as might be expected, the domestic rather than the scientific side of Silvanus Thompson's life.

We have taken some space to show what this book is not, because it is the duty of reviewers to see that possible readers are not misled by titles and publishers' announcements. It is, however, far pleasanter to say what this book is.

The general outlines of Silvanus Thompson's life are well known:—his early education in York and London; his appointment to the charge of the physics department of the University College, Bristol, and his translation, while still a young man, to be principal of "Finsbury," a post he was still holding at the time of his death. From that obscure and dingy building the influence the "Doctor" wielded was incalculable. The direct impression he made on electrical engineering progress was great, but it is hardly to be doubted that the indirect impression he made was much greater. It is said that the Scotsman has permeated to every part of the globe, and the same can equally be truly said of the Finsbury man. And wherever the Finsbury man is found there also is to be found a little of the Thompson influence. It is in this way his name will live rather than in his contributions to pure and applied science, valuable though these undoubtedly are. The arts of invention and research are common compared with that power to erect a lasting monument in the hearts of his colleagues and students which Silvanus Thompson undoubtedly possessed.

The book is not strictly biographical in its scheme, the historical method having been subordinated to the more convenient, if less logical, arrangement, of dealing with certain phases of the career as a whole and then passing on to another. This obviously leads to a certain amount of repetition, but is on the whole justified. It shows the many facets of Silvanus Thompson's character and reveals the man. We have no doubt the book will be widely read, and so it deserves to be. It is illustrated by a number of excellent photographs, and is well printed and bound. We have only been able to find two relatively minor misprints. In the appendix giving a list of honours and degrees, the Institution of Electrical Engineers is described as the Institute, and the Illuminating Engineering Society as the Society of Illuminating Engineering.

Labour Difficulties and Suggested Solutions. By W. J. Deeley, B.A. (London: Benn Brothers, Ltd.) Second Edition. Pp. x. + 230. 11s.

Anyone who has studied the development of what is conveniently called labour from the beginning of the industrial era to the present day cannot fail to be struck with the change in mental industrial conditions which have taken place during that period. Not only has there been a gradual amelioration of arrangements in the factories themselves, combined with a gradual improvement in the scale of living, but there has been a growth of what can only be termed sympathy between the employer and the employed. This statement probably seems so extraordinary when we consider the present labour unrest that it can hardly be put forward without qualification. We do, however, feel that the best of both employers and employees are beginning to realise that the goal for which each must strive in their own best interests is combination rather than antagonism.

What an advance—a real advance—this is will be evident from a comparative study of such volumes as those by the Hammonds on "The Skilled Labourer, 1760–1830," and the book by Mr. Deeley now under review. In the one we see the working man as a chattel, rather worse than better than a serf, unable freely to dispose of his labour, paid too often in kind rather than in money, working under horrible conditions, spied upon by his employer's agents, entitled to no redress in law, and forbidden to combine to protect his interests. In the other we see the worker in a position of paramount importance, and the employer, realising that to get the best out of his employees he must be studied and treated as a man. This change has not been brought about by Trades Unionism and strikes, but by a real advance in outlook.

It is obvious that the days are past when a man can be sacked for the slightest fault. For one thing, it is most inefficient to train a man for a particular job and then turn him off for some relatively trivial offence against discipline. Such a course, in Mr. Deeley's view, can only be avoided by producing goodwill and hearty co-operation between all grades, and this book sets out to show how this can be done in a most instructive and interesting manner.

The requirements of the manager and foreman are discussed in detail under such headings as technical knowledge of the trade, power of organisation, and skill in management of men as distinct from the management of the works. The hints to young foremen are admirable, and what the author has to say about such important matters as wages, rises, pensions, sick club, profit-sharing and co-partnership are well worth study, and show that he has a thorough grasp of his subject, even though they sometimes raise that feeling of opposition which is a sort of reaction from a well-put case.

We can heartily recommend this book to all those interested in labour problems. Employers and employed cannot afford to go on fighting. They must sink their differences and move forward together. There are difficulties in the way, no doubt; but such a discussion of them as Mr. Deeley's book affords will help to bring about their solution.

Correspondence.

THE TREND OF ELECTRICAL EDUCATION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The letter from Mr. H. Vickers in your issue of the 19th inst. cannot be allowed to pass unchallenged. It is a pity he spoils an otherwise excellent exposition on the subject of education by the—shall I say?—bitter remarks towards the end of his letter.

The fact that the ratio of men in "important positions" to those who are not is 1–100 (the education of all being equal) is no argument that "education forms a very small element in a man's success." It is obvious that we cannot *all* occupy the "important positions" in our profession; of necessity many of us must be "hewers of wood and drawers of water," although our education may have been second to none.

I have evidently been more fortunate than your correspondent, for the majority of the holders of "important positions" with whom I have come into contact are men who can claim a good education, and therefore, whether or not they have obtained their positions by "personal relations, bluff, long service, &c.," is beside the point.—I am, &c.,

London, March 19. H. C. Silver.

The Electrician.
FRIDAY, MARCH 26th, 1920.
Price ONE SHILLING. By Post 1s. 1d. Ann. Sub.: U.K. 52s., Abroad 54s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

The Electric Lamp Industry.

Is it Profiteering?

The searchlight of a sub-committee appointed by the Standing Committee on Trusts under the Profiteering Act has now been turned on a section of the electrical industry. To be suddenly illuminated in this way is equally unpleasant, whether the victim is fishing or laying mines. But because a boat is picked up by a searchlight is not sufficient reason for judging it hostile; and this should not be forgotten in examining reports of this kind. For most of them assume too readily that certain facts should be construed in the worst possible light, while the defendant is as often found guilty, not for what he has done, but for what he might do.

The Indictment.

We are not surprised that this particular report has caused some stir. Put in their blackest form, the conclusions are that the Electric Lamp Manufacturers' Association fixes the prices of all lamps sold in this country at such a figure that both the Association and the factors and retailers through whom they work are making an undue profit. If only a reasonable profit were taken vacuum lamps could be sold to the British public at 2s. instead of 3s. each, and as an example of profiteering a transaction where 1¼ million half-watt lamps were bought at 3s. and sold at 12s. 6d. per lamp, when 8s. would have been a fair price, is instanced. It is also pointed out the Association imposes limitations on the output of lamps, and that there is every chance that not only may the lamp industry of this country be unfavourably affected by American influences, but that prices may be controlled over practically the whole world.

The Defence.

At first sight this all seems so damaging as to admit of no reply, but there are one or two points to which we may draw attention, as it is eminently desirable that no stigma should attach to a branch of the electrical industry which, whatever may be said about it, has by its enterprise, foresight and energy conferred great benefits upon the public.

It will be noted there is no one possessing either electrical or even engineering knowledge on the committee. There should be at least one expert or assessor on these committees when technical matters are being considered. This would have been the more desirable in this case, as some of the conclusions have been reached either because false deductions have been made from the evidence presented or because ignorance has unwittingly led to the matter being looked at in an incorrect way. An example of the first of these is the statement that lamps are being exported at 1s. 4¾d. each, and sold in this country at 3s. each, when 2s. would be a fair price. We agree, if the facts were as stated. But we are given to understand that no lamps are exported at 1s. 4¾d., and if they were such price would show a loss. Now, trade combinations are not generally accused of being philanthropic bodies, so that we may accept this as a good reply. An example of the second type of conclusion is that a large number of lamps purchased in Holland for 3s. each were sold to the public in this country at 12s. 6d. each. We understand that, while it is true the list prices of these lamps was 12s. 6d., very few, if any, were sold at that price, which was admittedly fixed unreasonably high to prevent a public demand. As a matter of fact, the lamps in question were disposed of to Government departments and traders at a very much lower price. This point is one which has naturally attracted most attention in the industry, and we are glad an explanation has been so quickly forthcoming.

Are Associations in the Public Interest?

The general question, however, remains, Is the existence of associations or trusts in the public interest, or should steps be taken by the Government to limit their operations? In the case of the electric lamp industry it cannot be said that association has been harmful. Co-operation has permitted raw materials to be bought in larger quantities, and therefore more cheaply than would otherwise have been possible; and the development of a selling organisation and the establishment of research laboratories on a scale which no individual firm could even have contemplated. The work that has been done in devising new methods and designing new plant has been enormous. Ideas and machinery have been ruthlessly scrapped at great cost when occasion has required, but others have risen phœnix-like, and the result has been the production of a lamp not only of higher quality, but at a cheaper price to the public than hardly anyone would have thought possible a few years ago. And the Association is not resting, so that further developments are not unlikely.

When Associations may be Harmful.

Co-operation of this kind, in theory at least, has its harmful side. An influential trade organisation to-day can buy up patent rights, fix prices, regulate output, and dominate markets to its own advantage and to the detriment of the common weal. And while all these things can be done, and to a certain extent are done, it is a little difficult to see how they can be prevented, or if they could be prevented, whether the cure would not be worse than the disease. The electric lamp industry in this country is controlled by an Association which, it is admitted, is at least working in British interests. But over against it are Continental and American trusts, only too eager to seize our markets, and no Profiteering Committee has examined into their operations. The Electric Lamp Manufacturers' Association is a power which can and does withstand these influences not only in its own interests, but in the interests of British trade. If it were broken up it would not be easy for the constituent firms to fight big outside interests. It therefore seems a choice of evils, whether the electric lamp industry, or the glass or the rail industries for that matter, should be controlled by a British or foreign-owned association. We have no doubt what the answer, not only of electrical engineers but of the general public, will be to that question.

The committee, however, do not propose that the Association should be broken up, but that a Department of State should be established to watch the development of combinations tending to create monopolies. "The Times" approves the idea, and points out that it has been blessed by the Federation of British Industries. But we are not so sure whether it is the right solution. If an Association like this is a noisome growth on the body of trade it should obviously be excised. But is a Government Department fitted to perform the operation? Unadvised and unskilled surgery brings septicæmia in its train.

The Manufacture of Vacuum Cleaners and Electric Drills.

At first sight there does not seem much connection between a vacuum cleaner and an electric drill. This lack of connection is confirmed at second sight, and our only reason for introducing the two into the title is because they are both made together in the Victory Works of Messrs. Scholey & Company at Croydon, of which views are given in the accompanying illustrations.

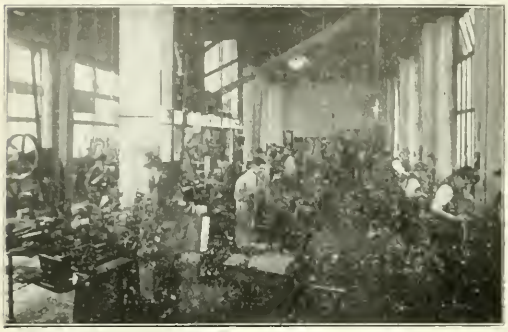


Fig. 1.—View in the Main Machine Shop.

The history of these works is interesting. They were started just as the Armistice was declared, at a time when a general trade slump was expected. This showed courage. They were designed to turn out articles which have generally come from the American market. This showed enterprise. And in spite of difficulties with labour, raw materials and high prices, they have been an undoubted success. This shows good management—and is a matter for congratulation.

The electric suction cleaner manufactured by Messrs. Scholey & Company is the well-known "Premier." This machine has no fewer than 200 component parts, so that a carefully organised system of manufacture is necessary to ensure it being turned out satisfactorily in substantial quantities. Great difficulty was experienced in buying a number of small parts, and in consequence almost every piece is manufactured at the works. This has necessitated a number of special tools and jigs, and the provision of a well designed toolroom. These cleaners are being made under extremely fine limits, an arrangement which is justified by the complete interchangeability secured. But another point which also had a good deal of influence on the use of fine limits was that these cleaners are made alongside electric drills.

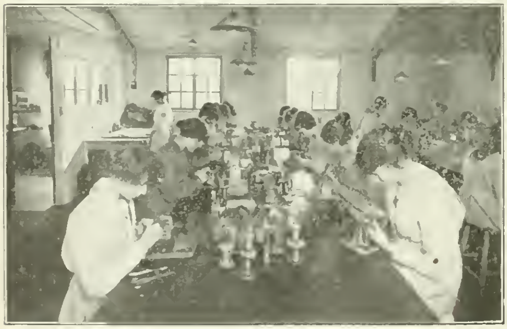


Fig. 2.—Winding Cleaner Armatures.

The manufacture of very small motors of 1-10 or 1-20 b.h.p. offers some interesting problems. They must be at least as reliable as the larger motors which generally get some measure of skilled attention, and in the interest of portability and price the speed must be kept high, especially as this also enables a reduced number of turns and larger and mechanically more reliable wires to be used. Normal speeds of about 10,000 revs. per minute have, therefore, been adopted on Messrs. Scholey's motors, although this means a frequency of magnetic reversals in the armature as high as 167 per second and necessitates careful lamination and the use of the best iron. It is also found a convenience to make the motors of the "Universal" type, *i.e.*, suitable for use on either direct or alternating current circuits up to 100 cycles per second. To meet this requirement plain series wound motors are employed. This has the added advantage of larger and safer magnet wires and reduced turns, whilst the usual objections to the larger sized series motors are immaterial with these small motors whether working a drill or a vacuum cleaner. In connection with speed the mechanical balancing of the rotating system is important. The armature case has, therefore, been carefully balanced by using a special divided winding which avoids the bunching up of the end windings commonly occurring with hand-wound armatures.

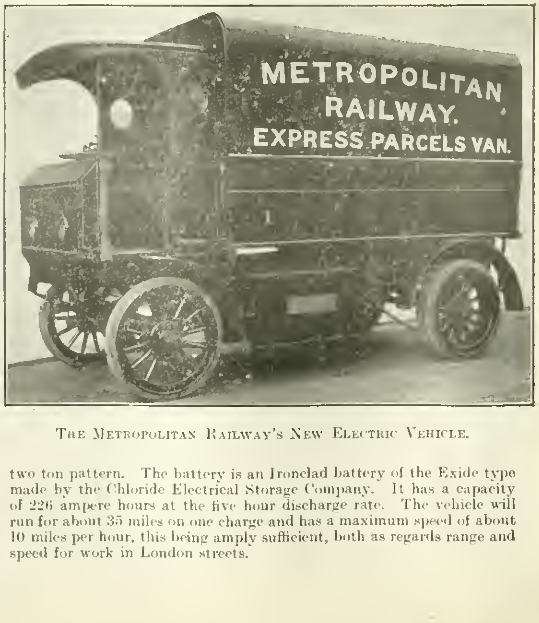
The base of the "Premier" cleaner is an aluminium casting embodying the suction nozzle, fan chamber and exhaust pipe, the power unit being an electric motor of 1-10 b.h.p., carrying a fan on the armature spindle, which sucks the air through the nozzle into the fan chamber, and exhausts into a stout dust proof drill bag. The motor is controlled by means of a rotary switch in the handle. The base castings are machined on all working and locating faces, and all holes in the casting are jigged so that any component is interchangeable. The motor case consists of two aluminium castings, the body being bored to accommodate the field magnet, cover and bottom bearing, and turned to fit its housing in the cleaner base, while the cover is turned to fit the body, and bored for the bearing and brush holders. The cover is secured to the body by means of two screws, and after assembly the bearings are finish reamed to ensure perfect alignment. The brushes are well insulated in fibre bushes and caps. The motor is secured in the base by means of two grub screws on an angle, making an air tight joint. The armatures are built up of laminations of best electrical sheet steel mounted on a spindle which is hardened and ground; after assembly the armature is finished on the periphery by grinding, thus ensuring as far as possible perfect balance; the commutators are assembled whilst hot, which practically eliminates any possibility of segments working loose should the machine become heated after a prolonged run.

The field magnet is built up from laminations which are made from best electrical sheet steel, secured together by means of four rivets and held in position in the motor case by means of two screws. The armature spindle runs in phosphor bronze bearings which are lubricated by contact with felt pads saturated in oil, so that seized bearings in these motors are practically unknown. All components are subject to a rigid inspection and test, and owing to an elaborate system of jigs, gauges and fixtures, interchangeability is guaranteed.

Similar care is taken in the manufacture of the portable electric drills. These are made in two sizes driven by a 1-10 and 1-15 h.p. motor respectively. The first of these will drill up to ⅜ in. in brass and up to ¼ in. in steel, while the latter will drill up to 3-16 in brass and ⅛ in steel. The larger drill is fitted with two speed change gearing.

Electric Railway Vehicle.

One of the most recent recruits to the electric vehicles of London is that shown in the accompanying illustration. It has been supplied by the General Vehicle Company to the Metropolitan Railway for the express parcel delivery service carried out by that undertaking in London. The chassis of this vehicle is of the standard General Vehicle Company's two ton pattern. The battery is an Ironclad battery of the Exide type made by the Chloride Electrical Storage Company. It has a capacity of 226 ampere hours at the five hour discharge rate. The vehicle will run for about 35 miles on one charge and has a maximum speed of about 10 miles per hour, this being amply sufficient, both as regards range and speed for work in London streets.



The Metropolitan Railway's New Electric Vehicle.

Commercial Topics.

Unworked Patents.

By an order of the Board of Trade April 1 has been fixed as the date for bringing into operation Sections 1 and 2 of the Patents and Designs Act, 1919. By section 1 action can be taken to ensure the proper use of patents which have not, within four years of the date of the patent, been worked in the United Kingdom on a commercial scale; while sec. 2 prescribes conditions under which licences for the use of patents shall be granted so as to ensure the widest possible use of inventions.

* * * *

Australian Electrical Progress.

In a recent issue we gave some particulars of the big scheme for the utilisation of the Morwell brown coalfield for the generation of electrical energy and for the transmission of energy to Melbourne, &c. It is now announced that the Sydney City Council proposes to expend about £1,500,000 in the erection of additional generating plant, the laying of feeder and distributor cables, &c., in the city and suburbs. These two schemes should represent a good many big orders for British electrical manufacturers—not only for generating and sub-station plant and cables, but also for electric motors, wiring, fittings, lamps, cooking and heating apparatus, &c.

* * * *

Trade With Canada.

At present there is an organised attempt to curtail imports into Canada from the United States, and as Canadian manufacturers cannot supply all local needs there should be a good opportunity for British exporters and manufacturers to capture some of the trade. Last year the value of the American electrical apparatus exported to Canada was nearly $11,000,000, machinery totalled over $45,000,000, electric light fixtures and glassware represented about $5,000,000, while iron and steel and their manufactures came to nearly $155,000,000. The movement to curtail American supplies is reported to be growing, and this should tell in favour of British goods.

* * * *

The Rating of Machinery.

Another attempt is being made to amend the law relating to the rating of machinery, and we hope that the promoters of the new Bill will be successful in getting the measure through Parliament. It is provided that the word " hereditament " shall include such machinery only as is " fixed or attached " to the hereditament. In the case of any hereditament occupied for any trade, business, or manufacture, the expression " fixed or attached " shall be construed as applying to all machinery, machines, or plant in or on the hereditaments for producing or transmitting first motive power or for heating or lighting such hereditament; but shall not apply to machines, tools, or appliances which are only so fixed that they can be removed from their place without necessitating the removal of any part of the hereditament.

* * * *

The Overseas Touring Exhibitions.

The Department of Overseas Trade proposes to organise a number of touring exhibitions of British manufactured goods, which will visit the principal commercial centres in the British Dominions, South America, the Far East and the United States of America respectively. The proposed exhibitions will inaugurate a novel departure from the usual type of stationary trade fair. Useful as are the existing annual British Industries Fairs for bringing the range of and the excellence of British products before the notice of the visiting buyer from abroad, the proposed tours should render far greater service to the British manufacturer who desires to expand his export business by taking samples of his wares direct to the overseas buyer in the latter's own town or country. Although many British manufacturers are already booked with home trade orders which will absorb their output for many months ahead, it is a wise policy to look ahead somewhat.

At present four touring exhibitions are contemplated. The first, the preparations for which are most advanced, will make a tour of the British Dominions. It is anticipated that it will leave England in June, visiting the chief cities in South Africa, Australia, New Zealand and Canada, and returning about July, 1922. The other three tours which are under contemplation will visit the principal commercial centres in South America, the Far East and the United States of America respectively. It is estimated that the displays will be on view for about a fortnight in each city. The exhibits will be packed, carried and displayed in specially designed show cases and packing cases, which will remain the property of the firms. The scheme is self-supporting, and it is anticipated that, on a basis of 500 exhibitors, each tour will cost from £200 to £250 (excluding cost of cases) per unit of space. Firms may apply for a half unit, or for one or more units, and there are five different types of show cases adapted to the varying requirements of particular trades. It is hoped that the three tours to foreign countries will leave England during the last few months of this year. The Far Eastern tour will include the chief commercial centres in India, Siam, the Straits Settlements, Dutch East Indies, China and Japan, and possibly Egypt, the complete journey occupying about two years. The South American tour will leave the United Kingdom in the late summer or early autumn, visiting Lima, Santiago, Buenos Ayres and Rio de Janeiro; and the U.S.A. tour will go to New York, Philadelphia, Atlanta, St. Louis, Chicago and San Francisco.

The total number of units in each tour will be limited to 500, and for the Dominions tour only applications received not later than the 31st inst. can be guaranteed consideration. A pamphlet containing particulars of the tours may be obtained from the headquarters of the Department, 35, Old Queen-street, London, S.W.1.

Electricity Supply.

The Corporation of ALLOA has purchased second-hand generating plant at Partick station of Glasgow for £20,000.

BRIGHTON Corporation has applied for sanction to a loan of £18,000 for extensions of the electricity undertaking.

ALFRETON Urban Council is endeavouring to get the Notts & Derbyshire Electric Power Company to extend its supply mains to the district.

At a meeting of MALVERN Urban Council last week it was reported that the number of electricity consumers had recently increased from 450 to 485.

LITTLEHAMPTON Council has authorised Mr. Prior, of Burgess Hill, to form a company for the purpose of supplying electricity in the district by means of overhead cables.

Referring to a paragraph in the daily press to the effect that HACKNEY (London) Council has prepared a scheme to extend its electricity undertaking at a cost of £305,000, we are informed that this is approximately the aggregate of amounts of expenditure already sanctioned for plant and mains extensions required in connection with the general development of the undertaking.

BOLTON Electricity Committee have decided to increase the price of current for lighting by $\frac{1}{10}$d. per unit (with a minimum charge of 30s. per annum) and for power consumers by $\frac{1}{5}$d. per unit. The kilowatt demand to bulk consumers will be increased in accordance with a graduated scale depending upon the demand from £3 8s. to £3 18s. per kilowatt demand, against £1 10s. to £2 10s. per kilowatt demand at present.

AMMANFORD URBAN COUNCIL, who have consulted Mr. Arthur Ellis as to the advisability of purchasing the local electricity undertaking from Mr. W. Herbert, have resolved that " it is expedient in the interests of the district that the Council should be the authority under the Electricity Supply Acts, 1882 to 1919, for the generation and supply of electric energy in the district," and the clerk has been instructed to take the necessary steps for the application for a special order under the Electricity Supply Act, 1919. Negotiations are to be opened with Mr. Herbert with a view to the purchase of the works.

BIRMINGHAM electric supply department is now able to remove all restrictions on the afternoon consumption of electric current. In November last the department had to inform consumers that, owing to the enormous demand for current, plant installed since the armistice must be disconnected from the mains from 3.30 to 5.30 each day. A large number of works were affected, and various expedients to avoid loss of production during the afternoon were tried, but with only limited success. The secretary of the department (Mr. E. J. Jennings) does not anticipate having to restrict the supply again until next winter. The new station will not be available until February next, completion having been retarded by the moulders' strike. The undertaking cannot take on any new consumers except for night supplies.

KIRKCALDY Electric Light Committee finds itself in a difficulty. Many big manufacturers are clamouring for an increased supply of electrical energy, but the capacity of the electricity station is insufficient to meet the demand and the Town Clerk has recommended the Council to sell the undertaking in view of the situation caused by the Electricity Act. In the meantime the Fife Electric Power Company offer to supply 600 kw., but the terms are not considered satisfactory by the burgh electrical engineer, Mr. O. F. Francis. The Committee recognises the urgency of the question and the pressing need of manufacturers for further supplies, and therefore it proposes to send a deputation to wait upon the Electricity Commissioners in London before they came to a definite recommendation for submission to the Council.

The following is a list of representatives who will act on the Employers' side of the HOME COUNTIES INDUFTRIAL COUNCIL for the ELECTRICITY SUPPLY INDUSTRY (No. 9 area):—Municipal: Ald. A. Wilkinson, Reigate (Chairman); Ald. Vaughan, Maidstone; Councillor Geo. Radford, Southend; Councillor Legg, J.P., Reigate; R. N. Torpy, M.I.E.E., (Borough Electrical Engineer, Tunbridge Wells); Robt. W. L. Phillips, (Borough Electrical Engineer, Bedford); and C. A. Blascheck (Chief Electrical Engineer, Canterbury). Company: Messrs. A. I. S. Baron (Frinton-on-Sea and District Company), W. E. Brandreth (Wycombe Borough Electric Light and Power Company), H. Leslie Dixon (Leatherhead and District Electricity Company), J. Eustace (Electric Supply Corporation, Ltd., Chelmsford), Arthur Grover (Hindhead Company), T. Hesketh (Folkestone Company), G. W. Spencer Hawes (Reading Company) and A. J. Wray (Banbury Company). The Secretary is Mr. T. W. Cole.

Electric lighting is being installed in the houses of the garden city near CHEPSTEW. At HYDE, where the Council proposed to employ gas for heating, cooking and lighting, the local Women's Housing Council are not satisfied with the plans, and demand that electric light should be introduced. At PRESTON the tramways engineer has been instructed to report on the possibility of supplying electricity to the Holme Slack and Ribbleton housing sites. At ARBROATH it is also proposed to adopt electric lighting.

On the other hand, DUNFERMLINE Council has taken up an reactionary attitude in the matter. The Housing and Town Planning Committee reported against electric lighting, and a majority of the Council has accepted this finding. In the course of the debate, Councillor Harley gravely said that " the best sanitary authorities to-day said that gas lighting was much more healthy than electric light." He did not tell his audience who these " sanitary authorities " were.

Electric Traction.

Ilford Urban Council is considering a proposal to adopt the railless trolley system as feeders to the local tramways.

As there is a loss of £150 a week on the Douglas (I.M.) cable tramways, the Committee has been urged to consider another form of traction or to discontinue the service.

Middlesbrough Tramways Committee has decided that when the Corporation takes over the Imperial Tramways Company's system in their area, at least one-third of the conductors shall be women.

Sunderland's first all-enclosed double-deck tramcar has just been completed. It is proposed to convert five more to an approximation of the L.C.C. tramcars, and 12 new cars on order are to be similar in type.

The London County Council has appointed a special committee to investigate the general conditions under which the Council's tramways are being operated. The members are: Messrs. A. A. Allen, F. R. Anderton, H. Arthur Baker, E. M. Dance, J. M. Gatti, H. H. Gordon, F. C. Harrison, G. H. Hume, W. C. Johnson, R. C. Norman, W. J. Squires, O. E. Warburg, Emil Davies and J. Speakman.

The Tramways Committee of Glasgow Corporation reports that of the 1,423 tramway employees medically examined, 20 were certified as unfit for the duties of motormen or conductors, but none of these men were dismissed for health reasons. The committee recommend that the present practice of the manager in endeavouring to find other employment in the department for the men certified medically unfit for motormen or conductors be continued.

As the outcome of a visit by a deputation from the Plymouth Works Committee to Birmingham and Sheffield to inspect the electric vehicles at work in the refuse departments of those towns, the committee has decided to order three electric vehicles for refuse removal at Plymouth—pioneer sweeper and loader and two tipping waggons, which also can be used as water tanks for street watering. It has been decided to apply for a loan for the purpose.

Though negotiations have been proceeding as to the Tramway Employees' Claim for an extra 10s. a Week, the parties have failed to reach an agreement. On Tuesday the National Joint Industrial Council of the Tramways Industries received a report from the sub-committee which waited upon the Minister of Transport on Monday. This was favourable, and expressed the view that the Ministry felt a case had been made out for legislation in regard to increased fares. The employers again submitted a proposition to the men's representatives, but this was not accepted.

An important announcement on the question of the contribution by omnibuses for road maintenance has been made by Sir Henry Maybury, of the Ministry of Transport. On the consideration of the Bill of the Leigh Corporation, who are seeking powers to run motor omnibuses in their own and outside districts, Sir Henry stated before a Select Committee of the House of Commons last week that the Minister of Transport was of opinion that a maximum of, say, 1½d. per omnibus mile should be paid in all such cases for maintenance charges. With regard to adaptation charges for making roads suitable to bear this particular kind of traffic, the Minister considered that a clause should be inserted in such Bills providing for the payment of a maximum sum of £700 per road mile. In the event of any difficulty arising, the matter should be settled by an arbitrator appointed by the Ministry. Hitherto, except in special cases, the maintenance contribution had been generally fixed at ¾d. or 1d. per car mile.

Imperial and Foreign Notes.

Wollongong (N.S.W.) Council has accepted an offer by the Government Works Department to supply electrical energy in Wollongong.

Dandenong (Victoria) Council recently decided to obtain a report upon a proposal that the Council should take over the local electricity supply works.

An agreement has now been arrived at for the supply by the Tasmanian State power station at Waddamana to Launceston Corporation, of 3,000 e.h.p. of electrical energy at £5 7s. per horse-power per annum.

The Government of the Federated Malay States is considering a scheme for supplying electrical energy for lighting and power in the principal towns.

In the Norwegian Budget for 1920 a sum of about £1,500,000 will be allocated to the development of water power.

The leading ladies of Amsterdam are organising an Ideal Home Exhibition to be held in the Paleis voor Volksvlyt from May 1 to June 7. the British section is being organised by Dr. W. R. Bisschop, who hopes that British manufacturers will take this opportunity of doing business in Holland. Applications for space should be made to Mr. F. W. Bridges, 36, Whitefriars-street, London, E.C.4.

A Swiss trade exhibition will be held in Basle from April 15 to 29, 1920. This is the fourth exhibition of its kind which has been held, the idea being to promote the sale of Swiss products in the home market. The foreign importer will, therefore, find it an excellent opportunity for becoming acquainted with genuine Swiss goods. The exhibits will be divided into a number of groups, including one dealing with the electrical industry and others dealing with lighting, heating, mechanical instruments and textile goods. Further information may be had from the Commercial Department of the Swiss Legation at 32, Queen Anne's-street, London, W.1, or from the Swiss Consulates in Manchester, Liverpool, Glasgow and Hull.

Institution Notes.

At the annual general meeting of Greenock Electrical Engineers' Association the following officers were elected: Hon. president, Mr. W. Blair Smith; president, Mr. W. M'Gibbon; hon. secretary, Mr. G. Fleming, Tramway Office, Ladyburn.

The following officers of the Bristol Association of Engineers have been elected for the next session (1920-21):—President, Mr. Nicholas Watts; vice-president, Prof. David Robertson; hon. secretary, Mr. H. T. Sully; and hon. treasurer, Mr. B. de Soyres.

At the annual dinner of the Institute of Metals last week, Rear-Admiral Sir William Nicholson said that in wireless this country led the world. Mr. Marconi told him before the war that no country had studied or perfected the organisation of wireless as the British Navy had done.

Institution of Electrical Engineers Scottish Territorial Centre.—The Committee have nominated the following officers for next session:—*Chairman*, J. E. Sayers; *Vice-Chairman*, E. T. Goslin and Alex. Lindsay; *Hon. Secretary*, J. Taylor; *Assistant Secretary*, W. F. Mitchell; *Chairman of Students' Section*, H. F. Whysall; *Committee*, H. Richardson and J. S. Nicholson.

The following officers were elected at the annual general meeting of the Batti-Wallah's Society last week: President, W. Wyld; and vice-president, W. E. Ireland. In addition to seven past presidents, the following were elected on the committee: E. Barralet, A. W. Blake, L. S. Richardson, J. P. Maginnis, R. Smith and H. Foulds.

The hon. sec.-treasurer is F. Pooley, and the hon. entertainment secretary A. J. Greenly.

The North of England Branch of the Association of Mining Electrical Engineers entertained a number of prominent members of the mining industry to lunch at Newcastle, on Saturday. It was stated that the Association had now 1,275 members and a balance of over £1,000. Since the Association was inaugurated the efficiency of electrical plant in mines had appreciably advanced. During 1913 in the North of England 11 accidents occurred which could in any way be said to be due to electricity, while in 1919 the number of accidents fell to seven, although the horse-power installed had increased during the period in question from 144,259 to 250,000.

The following officers have been elected to the Council of the Institution of Mechanical Engineers for 1920:—*President*, Capt. H. Riall Sankey, C.B., R.E. (retired); *Vice-Presidents*, W. H. Allen, H. Davey, Sir R. A. Hadfield, J. R. Hoyle, M. H. Robinson, Lord Weir; *Members of Council*, D. Adamson, R. W. Allen, Sir G. J. Carter, Prof. W. E. Dalby, J. Dewrance, Sir H. Fowler, H. S. Hele-Shaw, G. Hughes, H. A. Ivatt, C. W. James, D. B. Morison, Sir G. A. Muntz, Eng. Vice-Admiral Sir H. J. Oram, W. H. Patchell, Sir V. L. Raven, W. Reavell, D. E. Roberts, G. R. Sharpley, W. Taylor, R. Williamson, W. Worsdell; *Hon. Treasurer*, F. H. Norwood; *Auditor*, Raymond Crane, F.C.A.

The Main Committee of the British Engineering Standards Association will be constituted as follows from March 31: Sir Archibald Denny, Bart. (chairman), Sir Maurice Fitzmaurice, C.M.G. (vice-chairman), Sir J. Aspinall, Sir A. Duckham, K.C.B., Sir W. Ellis, G.B.E., Sir W. Matthews, K.C.M.G., Mr. Alex. Ross, Dr. W. C. Unwin (nominated by the Institution of Civil Engineers); Sir H. Fowler, K.B.E., Sir V. Raven, K.B.E., Dr. W. H. Maw (nominated by the Institution of Mechanical Engineers); Dr. A. Cooper, Mr. M. Mannaberg, Mr. B. Talbot (nominated by the Iron and Steel Institute); Sir W. E. Smith, C.B., Sir T. Bell, K.B.E. (nominated by the Institution of Naval Architects); Col. R. E. Crompton, C.B., Sir J. Snell, Mr. C. H. Wordingham, C.B.E. (nominated by the Institution of Electrical Engineers); Mr. F. W. Gilbertson, Mr. F. R. Davenport (co-opted by the nominated members to represent the Federation of British Industries); the Hon. Sir C. A. Parsons, K.C.B., Sir R. Glazebrook, K.C.B., and Sir R. Hadfield, Bart. (co-opted by the nominated members).

In the course of a Paper read before the Birmingham Electric Club last Saturday on "Advertising in the Engineering Industries," Mr. W. E. Warrilow said that advertising in industry meant selling, no matter how subtle the appeal. Truly remarkable results had been obtained by planning a selling scheme in conjunction with the production of some standard article; but mass production was useless unless the selling of the product was efficiently organised. There was no doubt as to the ability of British engineering firms to turn out the right article; what was now needed was the disposal of the article by attractive selling methods. Advertising, both through the mail and in the columns of the engineering press, was an immense help in reaching the right market. Electrical manufacturers had acquired the bad habit of designing some electrical article, turning out a small number and sending it to their customers for experimental use. This process seemed to be repeated indefinitely, so that the design of the article was constantly being changed and its price remained high. Mass production could only be undertaken when the experimental work was first done by the manufacturer, and the design of the article settled for an output of several hundred thousand. After that would follow the selling campaign. British engineering firms, Mr. Warrilow contended, had nothing to learn from American advertising. What any other country could do well the British could do better—if they would take the trouble. The habit of grouping among manufacturers had brought with it a tendency to publish association journals, but this was a form of publicity which cost large sums of money, in the production of which was obviously a glorified catalogue, lacking in the weight and authority which attached to an independently published organ. This policy required serious consideration at a time like the present, when there was a shortage of paper.

Miscellaneous.

While working at a switchboard at the generating station of the Central Electric Supply Company (Marylebone) last week a man named Arthur Pearce, who was employed by the British Thomson-Houston Company, accidentally received a fatal shock.

An interesting innovation is being made at the Strand-road works (Preston) of Messrs. Dick, Kerr & Company, who agreed to allow for a period of three months between the hours of 10 and 10.15 a.m. and 3 and 3.15 p.m. the privilege of smoking by the men on condition they continue with their work.

We are glad to be able to announce that the dispute between the Liverpool members of the Electrical Trades Union and the National Federation of Electrical Employers, which has existed since Jan. 9, has been amicably settled and the men have returned to work.

We regret to record the death of Mr. Anthony G. Lyster, formerly engineer-in-chief to the Mersey Docks and Harbour Board. After leaving Liverpool, Mr. Lyster joined the firm of Sir John Wolfe Barry, Lyster & Partners, consulting engineers. He was a past president of the Institution of Civil Engineers.

The Birmingham and District Electric Club held its annual dinner on Saturday last, the President , Mr. H. W. Wolton, A.M.I.E.E., A.M.I.M.E., being in the Chair. Over 100 members and friends were present, and the club is looking for a considerable increase in membership as a result.

We wish to dissociate ourselves from the statements made by Mr. Dunton in a recent letter in our columns. We have seen a copy of correspondence between Mr. Dunton and the College of Technology in which the Battery Rule is thoroughly thrashed out, and from which it appears that the College is not misleading "Manchester young electricians." Moreover, we think that, after the ample discussion which has taken place upon the matter, Prof. Walker is quite justified in taking no further notice of Mr. Dunton's attacks.

Mr. Boyd Cable, who in the later stages of the war, had an intimate knowledge of industrial conditions in munition works throughout the country, and has since written a good deal on industrial subjects, has been making investigations on the whole question of the high cost of living, and especially of food prices. The result of these investigations is to be published in a "Ways and Means" supplement to-morrow, and when they appear these investigations will make some sensational disclosures with regard to Government trading and Government profiteering, and also with reference to a recently formed alliance in the socialist and co-operative movement.

There was a regrettable increase in the number of street accidents in England and Wales during 1919, the total amounting to 45,544, compared with 33,456 in 1918. Of these 2,239 were fatal, against 1,852. Mechanically-propelled vehicles were responsible for 1,741 fatal accidents against 1,365. No fewer than 19,685 of the total accidents occurred within the Metropolitan Police District, while the City of London contributed 727. Mechanically-propelled vehicles were responsible for 575 Metropolitan and nine City fatal accidents. We had hoped that the good work of the Safety First Council would have led to a diminution in the number of accidents, and the figures show the need for greater publicity of the methods and recommendations of the Council.

At Warrington last week a successful smoking concert was attended by representatives of both employers and employees in the local electrical trade. Mr. F. V. C. Matthias, Borough Electrical Engineer, presided, and Mr. W. Shaw, chairman of the Manchester branch of the Electrical Contractors' Association, and past president of the E.C.A., who proposed the toast of "The Employees," said that in his long experience of the electrical trade that gathering was quite unique. The meeting represented the great "triumvirate" of the electrical industry, the contractor, the supply authority and the trades' union. If similar gatherings could be organised throughout the country many labour disputes might be amicably settled owing to the spirit of good feeling which such gatherings were bound to create.

An entertainment and dance, organised by the "Ediswan" Girls' Musical Society, was most successfully carried out on the 13th and 14th inst., at Ponder's End, and was largely attended each evening by employees of the Edison Swan Company and their friends. The affair was well stage-managed by Mr. D. Lishman, assisted by Mr. B. White, and the scenic effects and lighting were very effective. The committee responsible for the arrangements are to be complimented upon their organising ability. The Girls' Musical Society has only come into existence within the past few months, but under the direction of Mme. Carradine, many of the members are giving promise of considerable talent. In the main the programme consisted of songs, choruses and sketches, but principal interest was centred in a musical absurdity, entitled "Everything Electrical." The characters were as follows: Prof. Livewire, an inventor, Mr. D. Lishman; Prof. Basti Anita, his friend, Mr. S. B. Staines; Algy Dry Cell, his nephew, Mr. R. Bate; Jacko Flappo, his adviser, Little Jack; Maria, some slavey, Miss Flo Boyden; "Everything," Miss Winnie Melton. The instrumental music was supplied by the "Ediswan" Orchestra, under the leadership of Mr. F. Dean. The accompanist was Miss E. Smith.

An interesting dramatic performance is taking place this week at the Metropolitan-Vickers Club, Moss-road, Stretford, where the Metropolitan-Vickers Dramatic Society are producing a musical comedy entitled "The Squire and the Devil." The employees of the company are responsible for the libretto, lyrics, musical composition, arrangement of dances, scenery, dresses and lighting effects, besides furnishing the dramatic and musical talent. Similar performances have been given by the British Westinghouse Company employees for the past 10 years, though it is only during the last three, when the addition of the large new stage was made to the club hall, that they have been presented in the complete fashion of this latest performance. It would, therefore, seem that this annual function is in a fair way to become an institution. The parts of Squire and Devil are taken respectively by A. Cecil Busby and H. Cranfield Matthias, the principal ladies' parts being interpreted by Miss Mabel Winstanley and Kitty Shute. Miss Doris M. Walker arranged the dances, the orchestra was conducted by A. M. Parkinson, who also orchestrated the music, which was composed by G. H. Rowlands, and Maurice Hird wrote the lyrics and libretto, additional lyrics being written by Alec. J. Crawford, who also took a part on the stage. The performance as a whole is extremely creditable to all concerned.

Tenders Invited and Accepted.

Lincoln Corporation invite tenders by April 8 for the supply of pipework and a motor generator and switchgear.

Dunedin (N.Z.) Council require tenders by April 26 for electric car bodies, car trucks and equipment. Specifications from the Town Clerk

Leith Corporation want tenders by April 13 for one year's supply of overhead, electrical and car fittings, insulated wire, &c. Schedules, &c. from the Burgh Surveyor.

Newport (Mon.) Corporation require tenders by 10 a.m., March 27 for (1) tramcar bodies, (2) tracks, and (3) electrical equipment. Forms of tender, &c., from the Borough Electrical and Tramways Engineer.

The Ministry of Communications (Director of Telegraphs and Telephones), Athens, require tenders by May 13 for supply of wooden poles, galvanised and brass wire, insulators, telephone cables, exchange equipment, &c. Specifications from the Ministry of Communications.

The Secretary to the Tender Board, Public Works Department, Wellington, N.Z., will receive tenders until noon, June 30, for electrical equipment for the Arthur's Pass Section of the Midland Railway. Specifications from the Head Office of the Department, Wellington, N.Z.

St. Annes-on-Sea Urban Council require tenders (by 29th inst.) for three-core paper-insulated lead-covered and armoured pilot cable, stoneware troughing and covers. Particulars from the engineer, Mr. J. H. Clothier.

Sunderland Corporation invite tenders for two water-tube boilers, with integral superheaters, mechanical stokers, vertical c.i. tube economisers, steel plate chimneys, &c.; also one 1,000 kw. rotary converter. Specifications from the general manager, Mr. A. S. Blackman, and tenders to the Town Clerk by April 28.

Abertillery Urban Council require tenders by noon, April 3, for six or 12 months' supply of electricity meters, conduit and fittings, cables, wiring accessories, metal filament lamps, &c. Forms of tender from the Engineer of the Gas and Electricity Undertakings, Gasworks, Abertillery.

Canterbury Corporation invite tenders for one 1,000 kw. three-phase turbo-alternator and surface condenser two rotary converters and a superheater. Specifications from the consulting engineers, Messrs. May & Hawes, 36, Victoria-street, London, S.W.1., and tenders to the Town Clerk by 4 p.m., April 19.

Hammersmith (London) Borough Council invite tenders for supply of cables, conduit, e.h.t. and h.t. switchgear and static transformers. Specifications from the borough electrical engineer (Mr. G. G. Bell), and tenders to the town clerk, Mr. Leslie Gordon, Town Hall, Hammersmith, W. 6, by 4 p.m. on March 31.

Oudtshoorn (Cape Province) Municipality require tenders by April 24 for supply of a loco. type steam set with generator and switchboard, or, alternatively, (*a*) boiler and auxiliaries, (*b*) steam set with generator, (*c*) condenser and auxiliaries, and (*d*) switchboard. Specification from the Municipal Electrical Engineer.

Tenders are invited for the supply and delivery in Melbourne of two 2,000-kw. rotary converters and h.-t. and d.-c. switchgear. Specifications from the Agents of the City Council Messrs. McIlwraith, McEacharn & Company Proprietary, Ltd., Billiter-square-buildings, London, E.C. 3. Tenders to the Town Clerk, Melbourne, by April 12.

Aberdeen Corporation has placed an order for two boilers with the Sterling Boiler Company, at £41,000.

Shoreditch (London) Borough Council has placed orders with the Union Cable Company for the supply of cables of various sizes.

Bournemouth Corporation recently accepted the tender of W. Griffiths & Sons (at £139,236) for reconstruction of tramway permanent way.

Ilford Urban Council has accepted the tender of the General Electric Company for 1,000 kw. of converting plant, that of the Davenport Engineering Company for cooling tower, and that of W. T. Henley's Telegraph Works Company for l.t. cables.

The following tenders for machinery for sub-stations have been accepted by the Glasgow Electricity Committee: Bruce Peebles & Company, four 6,500-volt, 1,500 kw. rotary converters, with transformers, £36,400; Metropolitan-Vickers Electric Company, three 20,000-volt, 1,500 kw. rotary converters, with transformers, £29,310, and one 6,500-volt, 500 kw. rotary converter, with transformer, £3,790; British Thomson-Houston Company, one 20,000-volt, 1,500 kw. rotary converter, with transformer, £8,750.

Telegraph and Telephone Notes.

During his forthcoming yachting cruise in the Mediterranean Mr. Marconi is going to carry out some Experiments in Wireless Telephony and Direction Finding. Mr. Marconi's yacht "Electra" has been equipped with apparatus suitable for the purpose.

Deferred (as well as ordinary) Telegrams are now accepted at any post office for transmission to Canada by the State owned Imperial cable. The rates vary from 4½d. per word to the Eastern Provinces to 7½d. to the Western Provinces (excluding the more inaccessible parts of British Columbia and the Yukon).

The scale of telephone charges between England and France has been modified, and the charge for one conversation is 7 frs. 50 c. between Paris and London, Birmingham, Dover, &c., with 9·75 frs. between Paris and Liverpool, Manchester, Cardiff, Hull, Newcastle, &c. Ordinary night communications and subscription communications at night are at rates of three-fifths and one-half respectively of the above.

The Post Office accounts for 1918-19 show deficits in the case of both telegraph and telephone services. The actual net receipts of the two departments (including £5,456,573 put down as the value of services performed for other departments without remuneration) amounted to £16,193,289, while expenditure was £18,279,998. The ultimate financial results for the year were: Telegraphs—Deficit of £685,139, or £128,809 more than that of 1917-18; Telephones—Deficit of £36,261, against a net surplus of £355,468 in 1917-18.

The new Clerkenwell Telephone Exchange will be opened to-morrow when over 800 subscribers will be transferred from the London Wall, Holborn, Central and City Exchanges. A further 500 will be transferred on April 10. The new exchange is designed to serve the northern portion of the City, and is situated in Ironmonger-row. By the end of the year it will have a capacity of 10,000 lines. The apparatus will be of the manual type. Three other telephone exchanges will be equipped at the Tower, Holborn (old Inns of Court Hotel), and Marylebone. Alterations and extensions are also contemplated in the exchanges in the outer ring round London.

The Postmaster-General (Mr. A. Illingworth) states that the applications received for telephones during 1919 were 94,300; the number of new installations completed (excluding those for Government Departments) was 61,987. The total number of telephone instruments provided in these new installations and in extensions of existing installations was 103,686. The delay in providing telephone circuits in certain districts is generally due to shortage of spare wires in the underground cables or want of accommodation for additional circuits on the exchange switchboards, and to difficulty in obtaining from contractors an adequate supply of manufactured material.

Catalogues, Price Lists, &c.

A fresh price list of "Creda" hot-plates, grills, &c., has been issued by the Credenda Conduits Company, of Birmingham.

Leaflets on the current-carrying universal test clip and the universal battery charging clip have recently been issued by the L.P.S. Electrical Company, Avenue-road, Acton, W. 3.

Messrs. Haywood Foundries, Ltd., Seaton-street, N.W. 1, have recently issued their catalogue of high grade castings in non-ferrous metals with micro-photographs.

We have received from the British Thomson-Houston Company, Ltd., a copy of their 1920 Calendar, on which are illustrations of machinery, switchgear, &c., manufactured by the Company.

In list No. 219 of the Falkirk Iron Company, Ltd., illustrated particulars and prices are given of the latest type of "Falco" Electric Cooker. The prices are subject to the usual full trade and wholesale discounts and deliveries can be made from stock.

In publication No. 1,125 of Messrs. Marshall, Sons & Company, Ltd., a brief description is given of the Marshall "locomobile" engines, which are made in sizes ranging from 50 to 250 B.H.P. at normal loads. Engines of this class are suitable for central station work, and electrical engineers prefer them on account of their reliability, flexibility and steady running.

In publication No. 276 of the Sterling Telephone and Electric Company, Tottenham Court-road, W., illustrated particulars and prices are given of various types of electric bells and buzzers, relays indicators, bell pushes, door and window contacts, Leclanché batteries, accumulators, wires and wiring sundries manufactured and supplied by them.

A well-illustrated pamphlet of 24 pages of the Pontelec Welding Patents, Ltd., 46, Constitution-hill, Birmingham, gives the particulars of the electric welding plant and equipment supplied by them. The "Thomson" or resistance system is employed by the company, and this is claimed to be the simplest and most rapid while being free from risk to the operator. The company build any type of plant for special purposes, and the machines illustrated are also suitable for brazing or soldering.

A leaflet issued by the General Electric Company, Ltd., 67, Queen Victoria-street, E.C. 4, illustrates and describes the "Kingsway" and the "Expanda" telephone brackets. Generally it is desirable that the bracket should have a backwards and forwards motion, combined with a motion giving adjustment for height and a swivelling motion. The "Kingsway" Bracket, which is quite a new design, meets this case. Sometimes only two degrees of motion—backwards and forwards and swivelling—are required, and for these cases the "Expanda" bracket is suitable. Both brackets are neatly finished in oxidised copper.

Personal and Appointments.

Mr. O. A. Parker, of Torquay, has been appointed rolling stock superintendent at Wigan.

Mr. C. H. Jessop, of Rotherham, has been appointed constructional engineer at the Coventry Electricity works.

Mr. John W. Gilbert has been elected chairman of the County Council for the ensuing year; Mrs. Wilton Phipps is vice-chairman, and Mr. G. M. Gillett, deputy chairman. Mr. W. J. Squires has been re-elected chairman of the Highways Committee.

Prof. A. Fowler, of the Imperial College of Science and Technology, has been elected a corresponding member of the Paris Academy of Sciences, in the section of Astronomy.

Mr. W. W. Lackie, until recently chief engineer and manager of Glasgow Corporation Electricity Department, has been presented with a silver tray by the employees of the department on his appointment as Electricity Commissioner. Mr. R. B. Mitchell presided over a large gathering, and the presentation was made by Mr. John Gaw.

The friends of Mr. Norman W. Prangnell will be glad to hear that he has joined the staff of Messrs. C. A. Parsons & Company, at Newcastle. After his war service in the Navy he did not return to his old post of distributing engineer to the Metropolitan Eletric Supply Company. While waiting for a new opening he has been acting as Controller of the Engineering Stores Section of the Disposal Board.

On his retirement from the position of Director of the National Physical Laboratory, after 20 years, Sir Richard Glazebrook has received a farewell presentation from members of the staff at Teddington. Mr. F. E. Smith, chairman of the General Purposes Committee, presided over a gathering of about 600, and Sir Richard was presented with a portrait of himself and an album containing an illuminated address, the signatures of past and present members of the staff, and photograph of the Laboratory taken from an aeroplane.

Business Items, &c.

Messrs. Braithwaite & Wells have commenced business at Potter-street, Newport, Mon., as ships' telegraph manufacturers.

Mr. A. Berkeley, electrical supplier and agent, has removed to 111, Granville-street, Birmingham. Telephone No.: Midland 2807/8; telegrams: Arfwat Birmingham.

The Cardiff branch of Messrs. Johnson & Phillips, Ltd., has been removed to 2a, Court-road. The telegraphic address and telephone number remain as before.

Sir Isaac Pitman & Sons, Ltd., announce that all books formerly published by Messrs. Jas. Selwyn & Co., Ltd., of Essex-street, Strand, W.C., will in future be issued by themselves at 1, Amen-corner, E.C.

The Britannia Lamp & Accessories Company, Ltd., have disposed of their business, together with stock, patents, &c., to the English Electric Supplies, Ltd., Brook House, 191 and 192, Tottenham Court-road, London, W.1. The new company has taken over the entire staff and the branch offices.

Messrs. Berkeley & Young, Ltd., and the companies associated with them (the New British Electric Supply Company, Ltd., the Enclosed Motor Company, Ltd., and B.K.B. Electric Motors, Ltd.), have now returned to their old offices at Finsbury Court, Finsbury-pavement, London, E.C.2 (which were temporarily occupied by the Government).

Messrs. Handcock, Dykes & Trotter, consulting engineers, of 11, Victoria-street, Westminster, S.W.1, announce that, owing to the decision of Mr. A. P. Trotter to retire to the country, where he will devote himself to his special scientific subjects, the firm will, from the 25th inst., resume the old name of Handcock & Dykes, under which it was founded in 1894.

Should Wages Be Lowered?

In the course of a lecture on this subject, delivered before a meeting of the Industrial League and Council, Mr. E. J. P. Benn said that men and women who worked for a wage overlooked the fact that they were business men and women engaged in business. The fundamental fact was that they were working by giving services or goods to others, and they would only receive such goods with services as others were willing to give in exchange for their work. The greatest trouble in the world at the moment was that we were short of wealth, and the production of wealth was the one thing, therefore, that was most urgently required. No wealth was, however, produced by any Government or public organisation, and we should, therefore, be careful never to do anything to discourage the individual to put forward the best efforts that he could. It was a popular fallacy that individualism and collectivism were opposed to one another; but we must be careful not to fall into the error that collectivism and organisation were substitutes for individual effort. We must also endeavour to stamp out the doctrine that the interests of the employers and employed were necessarily antagonistic. Unless that was done we could never hope to make any progress. Nothing had ever been done in the way of progress without the incentive of profit or gain. "That being so," said Mr. Benn, "as a practical man, I remain a convinced capitalist and a believer in profits."

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications.

137,623 Joyce & Park Royal Engineering Works. Electric fusible cut-outs. (31 1 19.)
137,629 Ward. Holders for electric lamp shades. (5 2 19.)
137,635 Mossay, Jacoby & Enclosed Motor Co. Dynamo-electric machines. (10 2 19.)
123,321 Bopp et Cie. Apparatus for obtaining continuous or direct current from an alternating current circuit. (15 2 18.)

Apparatus comprises a device for reducing the tension of the alternating current, a rectifier, and a condenser traversed by the alternating current of reduced tension, and terminals from which the direct current is delivered, said terminals being tapped off from the plates of the condenser.

137,641 Van Raden & Co. & Smith. Electrical storage cells. (14 2 19.)
137,652 Bruce & Portholme Aircraft Co. Electric iron. (22 2 19.)
137,667 Roden. Electric magnetic rings, bracelets, thimbles, and the like, and the manufacture of the same. (7 3 19.)
137,675 Nelson & Reynolds. Electrical device intended for use chiefly as a toy. (13 3 19.)
124,747 Dispot. Means for actuating electric switches for controlling electrically-driven pumps. (21 3 18.)
137,695 Harris. Process for coating metal upon metal or other conductive flat surfaces for electrotyping for printing work and other like purposes, specially applicable to sound-reproducing records and the like. (31/3/19.)
137,704 Harrison. Make-and-break devices for magnetos and the like. (7 4 19.)
137,724 Cocking & Hean. Automatic cut-outs for electric circuits. (3 5 19.)
126,644 Chassin. Dynamo-electric machines. (11 5 18.)
137,736 Bundy & Bey. Method of and apparatus for grouping and supporting electric lamps for decorative illumination purposes. (20 5 19.)
137,748 Armstrong. Electric chain-welding machines. (16 6 19.)
137,754 Ide & General Electric Co. Holders for electric lamps and appliances therefor. (30 6 19.)
137,756 Siemens Bros. & Co. & Wood. Electrical connection boxes for electrically-operated cranes or machinery. (4 7 19.)
137,762 Stiles. Telephone lead and the like couplings for kite balloons and the like. (18 7 19.)
137,769 Railing & Hill. Electric cigar lighters, pipe lighters, and the like. (14 8 19.) (Addition to 119,141.)
137,793 Cracoanu. Multiple fuses for electric conductors carrying high-voltage currents (27 5 19.)
137,914 Fletcher & Ball. Eletric lamps or lanterns. (27 1 19.)
137,932 Lea. Electric couplings. (14 2 19.)
137,937 Yorke. Magnetic deflectors for electric arcs in lamps, searchlights, and the like. (20 2 19.)
137,958 Fletcher. Automatic coin-operated telephone calling-apparatus. (24 3 19.)
138,001 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Control means for electro-magnetic reciprocating devices. (23 5 19.)
138,007 Ames. Magnetos. (29 5 19.)
138,039 Ford. Electric kettles and the like. (27 8 19.)
138,043 Electrical Improvements, Ltd. & Beard. Electric reactance coils or transformers. (5 9 19.) (Addition to 133 135.)
138,147 Edman. Electric lamps for motor-vehicles and for other uses. (8/1/19.)
138,160 Bannister & Tucker. Trolley heads for electric trams and other purposes. (29 1 19.)
138,186 Harrison & Eyre. Means for securing electric lamps or lamp holders to hand lamps and other electric light fittings. (26 2 19.)
138,188 British Ever Ready Co. & Goodfellow. Self-contained electric battery lamps. (27 2 19.)
138,196 Ullmann. Phonographs for recording telephone conversations. (10 3 19.)
138,204 Amberton. Controllers for use with electric motors and so forth. (15 3 19.)
138,205 B. T.-H. Co. (G. E. Co. Protective devices for electric circuits. (17 3 19.)
138,226 Haigh. Papers for use as a di-electric for electrical condensers and other similar purposes. (9 4 19.)
138,227 Electric Construction Co. & Stirrup. Brush holders for use with dynamo-electric machines and for like purposes. (11 4/19.)
138,234 Corless. Distributor or commutator for Ford internal-combustion engines. (28 4 19.)
138,246 Lundberg, Lundberg, Lundberg & Pegg. Electrical switches. (17/5 19.)
138,257 Lutz. Electric insulators. (11 6 19.)
138,272 Olsen. Material for the manufacture of electrodes of electric furnaces. (6 8 19.

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

November 6, 1919.

27,397 B. T.-H. Co. & Frechman. Switches.
27,398 B. T.-H. Co. (G. E. Co.) Potective devices for electrical apparatus.
27,404 Vos. Electric pocket lamps.
27,431 Jensen & Tilney. Electric circuit breaker for ignition systems of engines, &c.
27,433 Radio Communication Co. & Lea. Wave-length or frequency indicators.
27,440 Macdonald. Electrically heating oil-bearing strata.

November 7, 1919.

27,455 Barker. Wireless telegraph systems.
27,456 Bolitho. Electric signal recording apparatus.
27,457 Allen & North. Magneto-electric machines.
27,462, 27,463 Miller & Sanders. Electric cable connectors for car-lighting dynamos, &c.
27,464 Miller & Sanders. Electric vehicle lamps.
27,471 Bishop & Chadwick. Chassis of trackless tramcars, &c.
27,472 Bishop & Chadwick. Electric trackless tramcars.
27,490 Chadwick & Walker. Electro deposition of aluminium.
27,498 Hawkins & Johnson. Electric lamp signalling systems.
27,511 Woodhead. Apparatus for converting tidal energy into electric power, &c.
27,530 Siemens & Halske A.G. Receiving arrangements for wireless waves. (18/6/18, Germany.)
27,597 Bolliger. High-tension direct-current electric machines.
27,605 Brella Mfg. Co. & Scorey. Electrical testing apparatus.
27,608 Gevrig. Automatic electric regulators.

November 8, 1919.

27,620 Lynch. Locking band for electric lamps.
27,627 Taylor. Distribution in alternating-current systems.
27,637 Healey & Smith. Ammeters, voltmeters, &c.
27,644 Walker. Electric switch, &c., mechanism.
27,656 Adriessens. Concentrating alternating-current arc extended by direct-current magnet to suitable lengths over small reactionarea. (8/11/18, Switzerland.)
27,678 Ford & Milton. Miners' safety lamps.

November 10, 1919.

27,706 Ball. Suspension chains for electric lamps, fittings, cables, &c.
27,721 Nalder Bros. & Thompson & Lipman. Frequency meters.
27,771 Westinghouse Lamp Co. Oscillating generators of the arc type. (9/11/18, U.S.)
27,804 Luzy. Electro-magnets. (1/2/18, France.)
27,811 Twiss. Electrical insulators.
27,904 Dechelle. Electric lighters. (22/3/19, France.)
27,976 Law. Switch for electro-medical apparatus.

Companies' Reports, &c.

The stockholders of the General Electric Company (of America) have authorised the issue of $50,000,000 7 per cent. cumulative preferred stock.

The directors of the Liverpool District Lighting Company, Ltd., have declared a dividend of 5 per cent. per annum (less tax) for the past year.

The Faringdon Electric Light & Power Company will be Struck Off the Register of joint stock companies unless cause to the contrary is shown before May 17.

The profit of the Tyneside Electrical Development Company, Ltd., for the year ended Jan. 31 was £4,534, and adding amount brought forward (£815) the total is £5,349. The directors propose a dividend at rate of 10 per cent. on the deferred ordinary shares, to transfer to general reserve account £1,000, leaving to be carried forward £849.

The Midland Electric Corporation for Power Distribution, Ltd., has paid a dividend of 10 per cent. (10s. per share) on the ordinary shares for the past year, adding £14,000 to depreciation, £5,000 to reserve and £500 to the redemption fund, writing £4,275 off issue expenses, and carrying £29,818 forward. The preference and ordinary shares of £5 have been divided into £1 shares, and at the meeting on Monday it was decided to increase the capital to £600,000 by the creation of 200,000 ordinary shares of £1 each.

During 1919 the Tramways, Light & Power Company, Ltd., made a profit of £43,947, and with £5,806 brought forward the total was £49,753. Loan and debenture interest absorbed £13,235, debenture redemption account £4,070, and the dividend on the preference shares to July 29 £8,167, leaving £24,281. A dividend on the ordinary stock from July 30 to Dec. 31, 1919, at the rate of 7 per cent. per annum, absorbed £10,448, a sum of £10,000 was transferred to reserve and £3,834 carried forward. The capital has been consolidated into ordinary stock, and the whole of the preliminary expenses and expenses of issues of capital written off. Large extensions of plant and mains in connection with the power companies are in progress, and the directors are to issue additional ordinary stock to provide funds for these extensions.

The directors' report of the London Electric Wire Company and Smiths, Ltd., for 1919 states that the contracts and orders on hand far exceed any total previously recorded. The usual provision had been made for depreciation, and £49,000 had been placed to reserve, making the general reserve £50,000 and the special reserve £20,000 respectively. During the year the issued capital was increased by £350,000. The directors recommend a final dividend on the ordinary shares, making 7½ per cent. (less tax) for the year, leaving to carry forward after deducting dividends already paid, £28,414. Sir George H. Fisher-Smith has been elected Chairman in place of Mr. W. H. Willey, who has retired, and Mr. W. J. Terry has joined the Board as a director.

Mr. F. E. Andrews, who presided over the meeting of Bruce Peebles & Company, Ltd., last week stated that during the past year they were to a considerable extent engaged in turning over from war work to normal engineering business. They had taken the opportunity to effect considerable rearrangements in the works, which had resulted in increased efficiency and a marked improvement in output. Their relations with their workpeople had been of a satisfactory nature. It was gratifying to know that with the enlarged works, and the larger number of men employed the output was more than 50 per cent. greater in value than the previous year, and that increase was reflected in the improved financial results shown in the accounts. A dividend of 7½ per cent. (less tax) was declared on the ordinary shares.

The profit of the Metropolitan-Vickers Electrical Company, Ltd., for 1919 (including £77,747 from last year), amounts, after providing for excess profits duty, to £303,007, out of which £35,000 has been appropriated to special depreciation of plant, &c., £100,000 to general reserve and the dividend on the preference and ordinary shares at 8 per cent. per annum (less tax) absorbed £116,917, leaving to be carried forward £51,089. The year has been one of considerable anxiety owing to labour troubles, not only in connection with transport, but with the iron foundries. In order to accommodate all the London staffs of the various associated companies in one building new office premises have been secured at No. 4, Central-buildings, Westminster, S.W., and it is hoped to remove to that address before the end of April.

Mr. Alfred R. Holland, who presided over the annual general meeting of the Llanelly and District Electric Lighting and Traction Company last week, stated that the receipts from both tramways and electricity supply departments showed an increase as compared with the previous year, but expenses had also been higher. The demand for electric power in the district had very materially increased, particularly during the last few months. In order to meet this demand, the boiler and generating plant at the power station had been increased, and cable extensions to Burry Port and Llangennech were in course of construction. When the extensions were completed and new consumers under contract connected up, the output of the station would be practically doubled, and negotiations were in hand for further large contracts. The district, which was a most important manufacturing centre, was rapidly developing, and the future prospects for electrical supply were most promising.

The revenue of the Metropolitan Electric Tramways, Ltd., for the year 1919 (apart from dividends receivable) amounted to £805,777. After deducting expenses, including debenture and loan interest, there remains £14,151, with sum brought forward and dividend receivable upon the Company's holding in the North Metropolitan Electric Power

Supply Company (£15,750), the available balance is £30,427. Of this sum £10,195 has been placed to reserve, a balance dividend on the preference shares of 3 per cent. per annum for 1917 absorbed £15,000 and ½ per cent. per annum on account of 1918 £2,500, leaving to be carried forward £2,732. In the early part of the year the North Metropolitan Electric Power Supply Company experienced a large reduction in output in consequence of the smaller demand by power users, but towards the end of the year this was regained by increased consumption of electricity for industrial purposes. That Company has declared a dividend on the ordinary shares at rate of 4½ per cent. per annum for 1919.

The net profit of the British L. M. Ericsson Manufacturing Company, Ltd., for 1919 after charging £12,582 for depreciation, £12,616 for income-tax, and £2,500 for debenture interest, amounts to £25,877, to which is added £51,279 brought forward. A dividend of 10 per cent. is to be paid on the ordinary shares, to reserve £10,000, to a reserve for depreciation of investments £2,500, carrying forward £48,656. Mr. W. M. Crowe, who presided over the meeting, said the prospects for the present year were extremely bright if they could only get raw material and sufficient output. They had in hand very large orders for telephone material of all kinds, further orders were waiting to be placed by the British Post Office, and there was an immense demand from the Colonies and from foreign countries. He regretted to say that the situation in regard to the necessity for increased output by the country had become worse since last year instead of better, but he hoped that the good sense of the worker would prevail. If the plans of the Labour Party for State control of mines, railways, shipping, &c., should become accomplished facts, he believed that the beginning of the end of the country was near.

The net profit of the Newcastle & District Electric Lighting Company, Ltd., for 1919 (after charging interest on debentures, &c., and allowing £16,000 for depreciation), was £8,494, which, with £13,099 brought forward, makes a total of £21,593. The directors recommend payment of a dividend at the rate of 4 per cent. (less tax) for the year, carrying forward £13,263. The capital expenditure for buildings, plant and mains during the past year amounted to about £19,001. The chairman (Lieut.-Col. F. R. Simpson) stated that the receipts showed a decrease of £7,959, due to the stoppage of the manufacture of war material, and the inevitable disorganisation of factories during reconstruction. There had lately been a marked recovery in the demand for electric power. In consequence of the increased cost of labour and material, the directors had to further increase the price of electrical energy, though the reduction of 10s. per ton in the price of domestic coal would enable the company to allow a rebate off the accounts of domestic consumers. They considered it advisable to lodge a petition against the Newcastle Corporation Bill, which contained clauses conferring upon the Corporation powers to supply electrical energy to consumers near their tramways which would affect the rights of the Company.

Addressing the shareholders of the Oxford Electric Company, Ltd., at the recent annual meeting Sir Henry C. Mance, C.I.E., said that the chief stumbling block to progress, the restrictions on the output, had been removed. When the colleges reopened and local normal conditions were restored, a substantial improvement took place, resulting in nearly 25 per cent. increase of business over that of the corresponding period of the previous year. In regard to the Electricity Supply Act, the efforts of the directors have been directed to secure fair compensation for the shareholders in the event of the Government desiring to acquire their generating station. Should such a contingency arise, he believed it would be optional to retain the distributing part, in which case their tenure, at all events of the profit-earning side of the undertaking, either independently or in amalgamation with other undertakings, would probably be established in perpetuity. It had become necessary, in order to provide funds for additional plant and machinery, to meet the anticipated increased demand to make some additional issue of capital. It was proposed to call the shareholders together in the near future to sanction either an increase of some sort in caiptal, or an increase in the rate of interest on the present unissued preference capital. The report and accounts were adopted, the dividend on the ordinary shares being at the rate of 5 per cent.

The connections to the system of the Newcastle-upon-Tyne Electric Supply Company, Ltd., at Dec. 31 last amounted to 316,737 h.p., an increase of 7,686 h.p. over 1918. The profit for the year is £248,194 (against £342,394), from which is deducted £30,000 carried to reserve for plant renewals, leaving £218,194 (£302,394), and adding £41,428 from 1918 the total available profit is £259,622, against which has been charged interest on debenture stocks, &c., £77,393, and the directors recommend payment of a dividend of 2½ per cent. on the 5 per cent. preference shares, making with the interim dividend 5 per cent. for the year, and a dividend of 5½ per cent. on the ordinary shares, making with the interim dividend of 2½ per cent. 8 per cent. for the year, and in providing for the portion of dividend accrued for 1919 on the 7 per cent. cumulative preference shares, leaving to carry forward £9,598. The expenditure on plant renewals and improvements during the year amounted to £30,010. The very unsettled conditions in trade have had a serious affect upon the revenue, but signs of improvement have shown themselves since the commencement of the current year. The additional capital expenditure for the year was £555,811, and represents further extensions at Carville and Dunston power stations, and of the company's distribution system generally, particularly in the northern area, where some important collieries are being connected to the company's system. Negotiations with the North-Eastern Railway Company regarding a supply of power for the electrification of its main line between Newcastle and York are proceeding. A housing scheme has been put in hand for the accommodation of the company's employees engaged at the new Tees power station, 73 houses being in course of construction.

During 1919 there were connected to the mains of the Harrow Electric Light and Power Company, Ltd., 172 kw. of additional demand were connected, making the total 2,643 kw., with 1919 consumers. The output was 622,477 units. The balance, including £377 brought forward and after deducting debenture interest and the interim dividend on the preference shares was £2,728. The directors recommend payment of the final dividend on the preference shares and a dividend on the ordinary shares at rate of 5 per cent. per annum. A sum of £200 was transferred to investment reserve, and £187 carried forward. Mr. J. N. Stuart, who persided over the annual meeting, announced that Mr. Butler had resigned from the board and was succeeded by Mr. A. Vassall. Last year's output was the largest for any year so far, and showed in increase over that for the previous year of 95,525 units (nearly 17 per cent.), resulting in increased receipts of £2,560. Working costs had also advanced considerably, notably in coal and wages. The increase in the gross profits of both the electricity and installation departments of £935 enabled the directors not only to increase the annual contribution to depreciation by £600, but also to revert to a 5 per cent. dividend on the ordinary shares. At the present time there was a big demand for electricity for household purposes, apart from lighting—for heaters, cookers and the numerous other small domestic appliances such as kettles, irons, suction cleaners, sewing and washing machines, &c., all of which helped to swell the revenue of the company. They had in hand considerable extensions of their mains to supply the new houses which were being erected in this area, totalling about 600, including the 200 being provided for by the Harrow Council's housing scheme.

At the meeting of the Brompton & Kensington Electricity Company, Ltd., last week, the chairman, Mr. H. R. Beeton, said the results of the past year's working were satisfactory beyond expectation, due in the main to the withdrawal of the lighting restrictions. The units sold—which until the month of October showed a decline—increased by 14 per cent. at the close of the year. The proportion of current sold for lighting and cooking was rather more than in the previous year, and that for heating and power rather less. After more than 30 years' occupation of their area they connected more customers last year than ever before, and recorded more lamp connections than in any previous year but one. That was mainly due to the growing conversion of large houses, many of which stood empty, into flats and maisonettes, and showed that they had still a large field awaiting cultivation. Their record load-factor was largely attributable to sedulous cultivation of their accessory load, and showed that they were working successfully to overcome the political difficulties which had overtaken them. The additional net revenue of £10,874 is due to increased receipts of £15,285, less increased expenses of £4,411. The increased expenditure was entirely attributable to the larger volume of business, the cost per unit sold being the same as last year, in spite of an increase in the cost of both coal and labour. The outlook was good if the general course of events be at all propitious. There was a growing demand for their product. The Accessories Company formed for the encouragement of cooking and heating continued to justify its existence, and constituted an asset which was beyond the reach of compulsory purchase. He concluded by paying a tribute to the energy and capacity of the general manager, secretary and heads of departments and staff.

The profit of the Automatic Telephone Manufacturing Company, Ltd., during 1919 was £15,724, and with £11,282 from 1918 the total was £27,006. After deducting directors' fees, depreciation and preference dividend (£17,664), there is a balance of £9,341. The directors regret that the profits will not allow of a dividend being paid on the ordinary shares. The decrease in profits is due to several causes, the most important of which were completely beyond the control of the Company; these were—reduction of estimated profits on the Company's manufactures due to the gradual inflation in labour rates and raw material prices, and reduction of output, due to the Government placing no orders for automatic telephone equipment during the year, and to the impossibility of obtaining delivery of the necessary raw materials in sufficiently large quantities to ensure economical production, &c. In view of these facts, the directors felt that advantage should be taken of a favourable offer, of which the holders of a majority of the shares had agreed to take advantage, and the new Company has been formed. The option to the preference shareholders of the Automatic Telephone Mfg. Company to convert their shares into shares of the new International Automatic Telephone Company has been extended to the 31st inst.

Mr. H. B. Renwick, who presided over the meeting of the South London Electric Supply Corpn. last week, said that they were paying a dividend of 6 per cent. on the ordinary shares instead of 5 per cent.; while £8,000 was being placed to reserve for depreciation (against £7,000), and £2,500 to general reserve, the carry-forward being £10,810, against £3,717. The receipts from sale of current and meter rentals increased by £21,349 (31 per cent.), and working costs and charges by £7,681 to a total of £51,562. An amount of £9,209 had been spent during the year chiefly on mains and meters. Expenditure of that nature was a sure indication of the vitality of the company's business, and now that the company was taking a bulk supply, nine-tenths of the expenditure in future would be under those heads. An additional 1,320 kw. had been connected, nearly half a million more units had been sold, and the consumers had been increased by 485, while the turnover on trading account showed an increase of £5,640. As to the current year, the units sold since the commencement showed an increase over last year of 17½ per cent., and the kilowatts applied for an increase of 18 per cent., while orders through the trading department were coming in at an increas'ng rate. After referring to the Electricity Supply Act, he said he was confident that, should the Government introduce another Bill this session, it would not again attempt to thrust upon electric supply companies a compulsory purchase clause on terms so harsh and infair as those in the original Bill. The company was quite prepared to take a bulk supply from a central source and to hand over its generating station to a central authority, but in such case the terms must be fair and reasonable.

Mr. L. E. Mather presided over the annual meeting of Messrs. Mather & Platt, Ltd., last week, and said that by the recent distribution of bonus shares the shareholders were only receiving what had been held in reserve for them during the last few years. Since the Armistice they had welcomed back 890 demobilised men, of which number 670 were with them before joining the forces. For the most part they had shown an excellent desire to settle down to industrial life. The works school for apprentices, which was held during working hours, had proved very successful, and was the first school of its kind in Manchester to be approved by the Board of Education. Every boy between the ages of 14 and 16 obtained instruction for eight hours a week, the teachers being provided by the local education authority. The improvement in the boys attending the classes had been very noticeable. The shorter hours and higher wages now obtaining had evidently come to stay, and provided that they paid more attention to the management side of business, and that the manual workers appreciated that skill here was also required, he had no fear for the future. After referring to the extensions made in progress, he said their trade prospects abroad were encouraging, in spite of fluctuating exchanges, difficulties in shipment, and the imparied purchasing power of countries which had suffered from the war. Their business in Russia had suffered temporary eclipse, and they had incurred heavy losses, which had been provided for in the accounts. They were already resuming business in Poland. The abounding prosperity of India and the removal of restrictions of various kinds had brought about a remarkable increase in the volume of orders from that country. They must, however, always look to the home trade as having the first claim upon the mand here there was a large valume of work already placed on order. One of their greatest difficulties would be to satisfy their customers at home and abroad in giving them deliveries in reasonable time.

At an extraordinary meeting of the British Aluminium Company, Ltd., last week, it was resolved to alter the articles of association. The chairman (Mr. A. W. Tait) explained that it was proposed to give effect to the recommendation made by the directors to increase the capital of the company to £1,500,000 and to capitalise a sum of £400,414, being part of the reserve account, and to apply that sum in paying up in full at par 400,414 ordinary shares, distributing the same to the holders of the existing ordinary shares. The directors felt that in making that recommendation they were justified by the inherent strength of the company's position, and in a manner they were only reinstating part of the capital which had been written off at the time of the reconstruction of the company 10 years ago, which amounted to approximately £520,000. The reinstatement was made out of the reserves which had been built since the reconstruction. The accounts for 1919 are not so good as those for the previous year, becanse of the fact that owing to the cessation of hostilities and the accumulation of stocks of metal in the hands of the Government and of the manufactnrers, there was a considerable diminution in demand, which continued for at least half of the year. Since that time the situation had improved and the demand was now good.

The report for 1919 states that the profit was £348,108, and, with £31,380 brought forward, the total is £379,488. After providing for income tax, depreciation of investments, &c. (£94,500), prior lien debenture service fund (£48,000), debenture stock service fund (£43,224), reserve for depreciation (£50,000), and amount carried to reserve (£50,414); also paying the preference dividend and the interim ordinary dividend at rate of 8 per cent., the directors recommend payment of a final dividend at rate of 12 per cent. per annum on the ordinary share capital (making with the interim dividend 10 per cent. for the year), eaving to be carried forward £15,314.

British Insulated Meeting.

The directors' report of the British Insulated & Helsby Cables, Ltd., states that the profit for 1919, after making provision for estimated liability for excess profits duty, amounts to £328,689, and with £99,292 brought forward, the total is £427,981. Deducting directors' and debenture trustees' fees (£7,165), interest on first debenture stock (£22,500) and on second debenture stock (£10,000) the preference dividend (£30,000) and interim dividend on the ordinary shares (£37,500), the disposable balance is £320,816. The directors have appropriated £50,000 to depreciation on buildings, plant, &c., transferred £50,000 to reserve and £5,000 to first mortgage debenture stock redemption account, leaving £215,816. The directors now recommend payment of a further dividend of 8¾ per cent. on the ordinary shares, making with the interim dividend, a total of 12½ per cent. for the year, 1919 together with a bonus of 2½ per cent., which will absorb £112,500, carrying forward, after making provision for excess profits duty, a balance of £103,316.

In the absence through indisposition of the Chairman, Mr. James Taylor, the Vice-Chairman (Sir J. S. Harmood Banner, M.P.) presided at the 24th ordinary general meeting on Monday. In moving the adoption of the report and balance-sheet the chairman said the profit for the year amounted to £328,688, compared with £288,280 for the previous year. With the exception of 1917 that was the highest profit earned in any year in the history of the Company. During the year all work for Ministry of Munitions was brought to a close, and a complete change over to the Company's ordinary business in wires and cables took place, and so great had been the demand for these that they had been subjected throughout the year to a constant pressure to deliver more than they could manufacture, and that pressure still continued. The same applied to the accessory products which now formed a very important part of the business. Having explained the items of the profit and loss account, he said that out of the balance for distribution (£215,815) the directors recommended payment of a further dividend of 8¾ per cent., making with the interim dividend already paid a distribution on the ordinary shares of 12½ per cent. for the year, and in addition a bonus of 2½ per cent., leaving, after making provision for estimated liability for Excess Profits Duty, £103,315 to carry forward. The Midland Electric Corporation for Power Distribution, Ltd., in which they were largely interested, continued its satisfactory progress, having declared a dividend of 10 per cent. on the ordinary shares, against 6 per cent. for the previous year. The position of the Electric Supply Company of Victoria, Ltd., remained much as previously described, and it had again paid a dividend on its preference shares.

Automatic Telephony.

He regretted that the Automatic Telephone Manufacturing Company, in which the British Insulated were shareholders, failed to pay a dividend on its ordinary shares in the past year. The principal immediate cause of this was the fact that the Government did not place any orders for automatic telephone exchanges during the year, and that an award of increased wages was made retrospective, thereby causing a loss of profit on materials sold and delivered during several months of the year, but apart from these circumstances the Company had been adversely affected by the war, which came at a time when in the ordinary course of events it should have been reaping the fruits of its pioneer work. The shareholders might have seen an announcement to the effect that the Government were going to spend a large sum of money on the telephones of the country, and that they were to have a splendid system in existence, but it was just as well for those who used the telephone to remember that it was going to be the old-fashioned system and not the automatic system adopted in America almost entirely and elsewhere, and in his opinion the Government would very shortly have to pull out what they were putting in and come back to them for automatics.

When practically at a moment's notice orders for war material ceased to come in a new and serious problem had to be faced, and it was due to the skill and foresight of the staff that orders for the manufacture of their standard goods had been secured and that they got so rapidly into their old swing. The changes which had been made during the war and the immediate patriotic duty to ensure the largest possible output of commodities made it necessary to rearrange the works and to add important buildings and machinery, and the very satisfactory results of the year's working was largely due to the devotion of the staff under new and trying conditions.

The motion for the adoption of the report and account was adopted, the retiring directors re-elected, &c.

An extraordinary general meeting followed, when, on the proposition of the Chairman, seconded by Sir Alex. Roger, a resolution was passed increasing the capital from £1,500,000 to £2,000,000 by the creation of 500,000 new shares of £1 each. The Chairman said in the future they might have to find enormous funds for stores, there might be big rises in price of material, wages were up, and they did not want to be caught so that when they found a favourable opportunity for the issue of capital they would not have the means at their disposal. There was not the slightest intention of an immediate issue, but they wanted to be ready when the time came.

New Companies.

ALABASTER LIGHTING WARE COMPANY, LTD. (164,377)—Private company. Reg. Feb. 23, capital £12,000 in £1 shares, to carry on the business of dealers in electric and other fittings. Each of the following companies—viz., Best & Lloyd, Edison-Swan Electric Company, Evered & Company, Galsworthy, Ltd., General Electric Company and F. & C. Osler—may, so long as it holds 1,000 shares, appoint a director. Reg. office: 84, Colmore-row, Birmingham.

ASSOCIATED ELECTRIC WELDERS, LTD. (164,990).—Private company. Reg. March 9, capital £10,000 in £1 shares, to carry on the business of electric welders, motor, mechanical and general engineers, &c. First drectors are: H. E. Eye, R. H. Charlton, H. Dring, J. Davison, D. Good, A. H. Gidley, H. R. Hookey and G. H. Unwin. Reg. office: 29a, Victoria-street, Grimsby.

ELECTRICAL & GENERAL SUNDRIES, LTD. (164,619)—Private company. Reg. Feb. 28, capital £500 in £1 shares, to carry on business indicated by title. Provisional directors are H. W. Cole and Evelyn Whittle (secretary). Reg. office: 14, Victoria-street, Westminster.

FRED ROTHWELL, LTD. (164,918).—Private company. Reg. March 6, capital £3,000 in £1 shares, to carry on the business of electricians, mechanical engineers, switchgear makers, &c. First directors are: F. Rothwell, 50, Crankeyshaw-road, Rochdale, also engineer, and E. Grimshaw.

HALL BROTHERS (MANCHESTER), LTD. (164,574).—Private company; reg. Feb. 27, capital £10,000 in £1 shares, to take over business of manufacturing electric and mechanical engineers, millwrights and merchants carried on at 11a and 11b, Eastnor-street, Old Trafford, Manchester, as Hall Brothers. First directors are W. Hall, S. E. Hall and H. Ratcliff.

INTERNATIONAL AUTOMATIC TELEPHONE COMPANY, LTD. (104,393). —Reg. Feb. 23, capital £920,000 in £1 shares (200,000 preferred, 360,000 ordinary and 360,000 deferred), to acquire (1) all or any of the shares or securities, and all or any of the assets and liabilities of the Automatic Telephone Manufacturing Company, and any other company, whose objects include the business of manufacturers of or dealers in automatic or other telephones, telegraphs or other electrical contrivances or apparatus connected therewith and (2) licences from the Automatic Electric Company of Chicago to operate, use and exercise in Europe and elsewhere inventions relating to such contrivances or apparatus, &c. Reg. office: Royal Liver-buildings, Liverpool.

PREMIER ELECTRIC WELDING COMPANY LEITH , LTD. (10,978) Private company. Reg. in Edinburgh Feb. 20, capital £8,000 in £1 shares, to carry on the business carried on by the North British Electric Welding Company (Eastern), Ltd. Secretary: A. L. Haggerty, Bank-buildings, St. James'-street, S.W.1.

P. S. C. COMPANY, LTD. (164,124)—Private company. Reg. Feb. 16, capital £3,000 in £1 shares (1,000 cumulative preference), to carry on the business of electrical engineers, agents for commutator bar copper, &c. First directors are Major P. Garton, Capt. J. M. Campbell, Major A. P. Reed and Major C. Suckling. Reg. office: 64, Victoria-street, Westminster, S.W.

RADIO ENGINEERING COMPANY, LTD. (164,409)—Private company. Reg. Feb. 23, capital £5,000 in 5s. shares, to carry on the business of mechanical and electrical engineers, instrument makers, &c. Solicitor: J. Hoare, 3, Crooked-lane, E.C.

RASHLEIGH PHIPPS & COMPANY, LTD. (164,318).—Private company. Reg. Feb. 20, capital £50,000 in £1 shares (5000 employees'), to take over business of electrical engineer and manufacturer carried on by A. Rashleigh Phipps, at 147, Oxford-street, W. Permanent governing director: A. Rashleigh Phipps.

SCOTTISH WELDING & SHEET METAL COMPANY, LTD. (11,007).—Private company. Reg. in Edinburgh, Feb. 28, capital £3,000 in £1 shares, to carry on the business of electric and oxy-acetylene gas welders, engineers, &c. The first dreetors are: A. R. Duncan, J. Johnson, R. D. Moncur and C. A. McArthur. Reg. office: 129, Union-street, Aberdeen.

SEWELL ELECTRIC COMPANY, LTD. (165,085). Private company. Reg. March 10, capital £2,000 in £1 shares, to carry on the business of electricians, mechanical engineers, &c. First directors are: C. Lord and J. Wilkinson. Reg. office: 12, Kelso-road, Leeds.

SPHINX MANUFACTURING COMPANY, LTD. (164,366).—Private company. Reg. Feb. 21, capital £30,000 in £1 shares (15,000 preferred) to carry on the business of manufacturers of and dealers in sparking plugs and terminals, magnetos, &c. First directors are: H. G. Longford and W. A. Clark. Reg. office: 242, Bradford-street, Birmingham.

TEES SIDE ELECTRIC & PLUMBERS' STORES, LTD. (164,903).—Private company. Reg. March 5, capital £2,000 in £1 shares, to carry on the business of manufacturers, importers and exporters of and wholesale dealers in electrical plant, plumbers' merchants, general electrical engineers, &c. First directors are: E. Phillips, F. Thompson, Henrietta Hayman and R. Winspear. Reg. office: 76, Reed-street, W. Hartlepool.

UNION ELECTRIC WELDING COMPANY, LTD. (164,940).—Private company. Reg. March 6, capital £15,000 in £1 shares, to carry on the business of electric, blow-pipe and other forms of welding and soldering, &c. First directors are: H. H. Fletcher, G. W. Roger, J. M. Wilkinson, E. H. Jones, W. A. Hunter and J. Caldwell, M.I.C.E., M.I.E.E.

Prices of Metals, Chemicals, &c.

Tuesday, March 23.

		Price.	Inc.	Dec.
Copper—				
Beat selected.........	per ton	£116 0 0	—	—
Electro Wirebars...	..	£118 0 0	—	£2 0 0
H.C. wire basis......	per lb.	1s. 3$\frac{15}{16}$d.	—	$\frac{1}{4}$d.
Sheet	,,	1s. 6d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7$\frac{15}{16}$d.	—	$\frac{1}{4}$d.
Brass 60/40—				
Rod, basis	,,	0s. 11$\frac{7}{8}$d.	—	$\frac{1}{4}$d.
Sheet, basis	,,	1s. 4$\frac{1}{4}$d.	—	2$\frac{1}{4}$d.
Wire, basis	,,	1s. 4$\frac{3}{4}$d.	—	—
Iron—				
Cleveland Warrants	per ton	£10 7 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£44 10 0	—	—
Lead Pig—				
English	,,	£48 0 0	—	£2 0 0
Foreign or colonial	..	45 0 0	—	2 12 6
Tin—Ingot	,,	355 0 0	—	28 10 0
Wire, basis	per lb.	0 4 5	—	4d.

Salammoniac.—Per cwt. 95s. and 90s.
Sulphur (Flowers).—Per ton £22.
,, (Roll Brimstone).—Per ton £22.
Sulphuric Acid (Pyrites, 168°).—Per ton. £8 8s. 9d.

Copper Sulphate.—Per ton £48
Boric Acid (Crystals).—Per ton £74.
Carbon Bisulphide.—Per ton £56
Sodium Bichromate.—Per lb. 9d.
Sodium Chlorate —Per lb. 5$\frac{1}{2}$d.

Rubber.—Para fine, 2s. 5$\frac{1}{4}$d.; plantation 1st. latex 2s. 6$\frac{1}{4}$d. per lb
Shellac.—T.N. Orange, 780s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co., Ltd.

Forty Years Ago.

(The Electrician, March 27, 1880.)

The Berlin Electric Railway. Permission has been granted to Dr. Werner Siemens to erect an electric railway between Wedding Platz and Belle Alliance Platz, without an intermediate station.

Electric Chlorophyl. Our contemporary "Nature" gives the following epigram on Dr. Siemens' recent researches:

Quis veterum vidit plantas sine sole virentes
Germinat en semen Siementis lumine claro.

Swan's Electric Light. Mr. Swan, the anticipator of Edison's cardboard lamp, has had his researches interrupted for a time by a disastrous fire. His engine and magneto-electric machines escaped, though most of his lamps and other apparatus suffered. He is now aiming at the production of a permanent lamp on the incandescent principle.

Henley's Telegraph Company. The telegraph and other works of Mr. W. T. Henley, situate at North Woolwich, were taken over as from 1st instant by Mr. W. T. Henley's Telegraph Works Company, Ltd., who are carrying on the business as manufacturers of submarine and land telegraph cables, wire and appliances, galvanised corrugated sheets, galvanised strand fencing wire, &c., Henley's patent cores, &c. Mr. Henley retains considerable interest in the company, and his valuable services have been secured.

The Telephone in Courtship.—A telephone was established between the Palace of the Pardo, where the Archduchess Maria Christina was staying prior to her marriage, and King Alfonso's palace at Madrid. Mr. Edison had, in all probability, never dreamt of such an application of his invention, and this new manner of paying court to a fair lady will, no doubt, in future be frequently adopted in Spanish high life, so that the occupation of the duenna, to whose keeping the betrothed was usually confided till the date of marriage, will become, like many other occupations of bygone times, a tradition of the past.

Is it True? Our contemporary "The Engineer," in a notice of Mr. Reid's work, "The Telegraph in America," concludes with the following: "A valuable feature of this work is the vast amount of information given as to the cost of the American lines, the methods of working, and so on, enabling the reader to compare the administration with those of other lines. It will be strange if hints cannot be obtained from the material supplied, even for the better working of our own system. One fact, we think, is unmistakably shown in this book, and it is that the men employed in telegraphy in America take a much greater interest in all that concerns their duties than do those holding similar positions in England."

The Society of Telegraph Engineers. The following has been sent to all members of the society: "Sir: The Council are of opinion that the present title of the society is not sufficiently comprehensive to indicate the full scope of the objects for which it was established—viz., 'for the general advancement of electrical and telegraphic science,' and that we consequently fail to secure the support not only of many of that large and increasing body of electricians who, although not telegraph engineers, are professionally connected with other practical applications of electricity, but also of those who pursue the subject from a pure love of science. They therefore recommend that the title shall be 'The Society of Telegraph Engineers and Electricians.' The Council are desirous of giving every member and associate the opportunity of expressing approval or disapproval of the proposed change before submitting the matter formally to a general meeting, which they purpose doing in November next; and I am accordingly instructed to request that you will favour me as soon as possible with your views on the enclosed form of reply, in which a blank space is left for the insertion of the word *not* in the event of your dissenting from the proposal."

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics":—"Cairo-Cape Flight: Two cases of Sabotage," by Major C. C. Turner; "Inner History of the Big Aircraft Deal"; "Vindication of the Aero Engine."

"Chemical Age":—Concluding article of series on "The British Fine Chemical Trade"; "The Use of the Refractometer in Chemical Industry," by P. J. Fryer; "Colloidal Clay in Soap Manufacture"; Dr. Zacharias (Athens) on recent articles in "The Chemical Age."

"Fruit Grower":—"Report on London Wholesale Markets"; "Fruit and Potato Trades' Federation Conference"; and "Hull Sale Rooms Controversy."

"The Gas World":—"Rival Gasification Processes"; "Southern District Association of Gas Engineers and Managers"; and all the gas news of the week.

"Hardware Trade Journal" (Spring Issue):—"Labour Saving in the Foundry" (VI.), by Joseph Horner; "Money: What it is and How it Works," by E. J. P. Benn; "Gas in Relation to Increased Output"; and Institute of Metals Annual Meeting (continued).

"Cabinet Maker" (Spring Number):—"Colour and Form," by Minnie McLeish; "The Art of Home Making," by J. H. Rudd; "Loose Covers: How to Cut and Make Them," No. VII.; and "The Test of Time."

"Ways and Means":—Special Survey No. 2, "Miscontrol or Decontrol"; "Government Food Trading and Nationalisation," by Boyd Cable; Financial Article by Sir George Paish; The "Capital" Party, by the Editor; and "New Income Tax Code," by John Burns, W.S.

THE ELECTRICIAN.

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,185. [No. 14. Vol. LXXXIV.] FRIDAY, APRIL 2, 1920. PRICE ONE SHILLING. By Post, 1s. 1d. Abroad, 1s 2d

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Notes.

The Electrical Equipment of Artisan's Dwellings.

A HOUSE is almost as personal a thing to a man as it is to a snail. The truth of this will be admitted by anyone who has spent a portion of the last five years in certain districts of France. On arriving at a new place the first action was to find somewhere to live and the next to impress upon that somewhere those indefinable touches which somehow made it instantly seem more homelike. This close interconnection between the man, and the woman too for that matter, and the house in which he lives must not be lost sight of in the development of these wonderful housing schemes of which we hear so much. A house is not home unless it is homelike, and anything electrical engineers can do to assist in making it homelike should be done not only for their own, but for the common, good. The Paper read by Mr. LEONARD MILNE before the Institution of Electrical Engineers last week on "The Electrical Equipment of Artisans' Dwellings" was opportune. But the discussion was disappointing, because most of the speakers allowed themselves to wander off into a maze of technicalities instead of sticking to the main problem. This main problem, as we see it, is just this: How can electrical devices be best introduced into the houses which are now being built? It is essential that these houses should be electrified, and this being so, the cost, and the profit too, must for the moment be secondary considerations, especially as, according to Mr. BEAUCHAMP, the cost of installing even the most expensive system would only be about 3 per cent. of the cost of the house. To ensure that electric lighting is installed, municipal authorities, architects, surveyors and all those sort of people must be approached and won over, educational campaigns must be started and the advantages of electricity must be brought to the fore in every possible way. Mr. CASH hinted that it would be better to put money into good work than into propaganda. But the first thing is to get the contracts before discussing how they are to be carried out.

Rival Wiring Systems.

THIS tendency to try and catch the hare before cooking it must not, however, lead us to disparage the value of the technical parts of the discussion. Mr. MILNE's suggested method of wiring artisan dwellings is to use an insulated No. 20 S.W.G. wire with a bare No. 20 S.W.G. wire wound in long spirals round it, the whole being braided over all, and to dispense with switch drops by placing a combined switch and ceiling rose on the wall near the ceiling level, running a twin flexible to the lighting fitting, and operating the switch by a rod or cord. This, in his view, would ensure branch switches being placed on the live side of the system and generally be less conspicuous than using several wires run on cleats. This arrangement seems to us to have the grave disadvantage that, in the event of a neutral wire being damaged, the area served would develop a series of intermittent faults inside the houses leading to a destruction of the insulation of the adjacent outer and at each point a short circuit would be created which would be fed by any leakage net-work current from either outer. An insulated neutral seems, therefore, to be essential, if for no other reason than the earthed neutral on the network can only be maintained when the conditions of the outers so permit. If there is any undertaking which has allowed its neutral to become earthed except through a controlled path it must be living in a fool's paradise. But even in such a case there is all the more reason for maintaining the insulation on all conductors on all installations inside buildings at the highest possible value. Neglect of this has resulted in great trouble with some of the earth sheathed (metal) systems of wiring. On the other hand, the prejudice against wires carried on porcelain cleats and exposed to the worst that the average householders may do seems a little exaggerated. We do not wish to ram Continental practice down the throats of our readers, but it is only right to point out that this system has been used for many years in Switzerland and Italy without any very harmful effects on the population who, there is no reason to believe, are less averse to using wires as clothes lines or supports for doll's swings than householders in this country. But all these criticisms, however interesting, are rather beside the point which is that, at whatever cost, we must ensure that all these new houses are equipped first with electrical lighting, and then, as occasion serves, with electrical cooking and heating apparatus.

The Restoration of Pre-War Practices.

During the war many trade customs and practices were suspended to allow of the employment of women on work usually performed by men. The Restoration of the Pre-War Practices Act of 1919 was passed in order to restore these practices, but already disputes have arisen as to the construction of Section 1 (1) of the Act, which provides that where in any establishment to which this Act applies, any "rule, practice or custom obtaining before the war in any industry or branch of an industry" (referred to as a trade practice) has, during and in consequence of the present war, been departed from, the owner of that establishment shall be under an obligation, at the expiration of two months from the passing of the Act, to restore or permit the restoration of the trade practice previously obtaining." The Munitions Tribunal at Manchester has decided that this section does not apply to the manufacture of a German miner's electric lamp, which was not made in this country until after the outbreak of war, and so women can be employed by the firm who now manufacture it. This is contested by trade unionists, and as there is likely to be an appeal against this decision we refrain from commenting upon it. Another interesting case has recently been before the Scottish Judge of Munitions Appeals, who has reversed a decision of the Glasgow Munitions Tribunal. It appears that an engineering firm, which introduced female labour on light work, still retained three women on that work. Prior to the war they had not employed women, but they pleaded that there was a pre-war trade practice of employing female labour on similar work, and that though they had departed from their own practice they had not departed from the trade practice. The Tribunal held that a trade practice within the meaning of the sub-section quoted above was "the practice prevailing in the particular establishment in question, and not the practice generally prevailing in the trade." From this decision the firm appealed. Lord Sands reversed the judgment and sent the case back to the Tribunal in order to determine whether "there is any rule, practice or custom obtaining in the industry (brass founding) against the employment of women at light core work." We believe the decision of Lord Sands to be sound and in accordance with the plain meaning of the Act. A rule of a particular firm in a branch of industry cannot be said to be a rule, practice or custom in that industry. If the whole or even a majority of the firms engaged in an industry had adopted a certain rule or practice then the case would be different.

The Shop Load and Electricity Supply.

At this time of the year the electricity supply engineer becomes a sort of Mr. Jekyll and Mr. Hyde. One of him rejoices that a beneficent legislature has given him an hour's extra daylight just in time for the Easter Holidays, and the other of him sees in the shade of the late Mr. Willett a subject for anathema rather than canonisation. This year the latter feeling is in the ascendant. For the ghostly person just mentioned has entered into an alliance with that much-maligned lady D.O.R.A., and if the Bill now before the House of Commons becomes law a sort of permanent daylight saving will be applied to shops by enforcing 7 o'clock as the hour on every week night except Saturday. This means a difference of about 550 lighting hours a year on the old basis, or of about 500 hours a year with summer time in force. The load factor of shop lighting is, therefore, 6⅓ per cent. under the old, and 5¾ per cent. under the new conditions. Moreover, the service is idle for five months out of the twelve, and when it is in use its full load comes right on the winter peak. This is a situation which obviously needs immediate improvement. Such improvement might be effected by propaganda in favour of window displays after the shops were closed, and especially in favour of employing electricity for such purposes as driving goods hoists, vacuum cleaners and for small power work of all kinds. The possibility of developing the heating load in shops is also worth consideration. This might well be done on the understanding that the radiators were cut off for half-an-hour just when the winter's peak was most acute. It must not be forgotten that many shops are obtaining their energy for lighting at a lower rate than the private consumer, and if this is to be justified every effort must be made to increase the value of this business to the supply authority.

The Use and "Abuse" of Mechanical Stokers.

The Paper on "Mechanical Stokers," read by Mr. David Brownlie at the last meeting of the Institution of Mechanical Engineers, gave rise to a discussion whose pungency and humour were as unusual as they were delightful. This was, perhaps, to some extent, due to a sense of incongruity. For as the ordinary mortal is tickled to laughter in church by incidents which outside the sacred building would hardly bring a smile to his lips, so the interest roused by this discussion may have been partly due to reaction from the dullness of the happenings which immediately preceded it. It was hardly to be expected, however, that Mr. Brownlie's challenge would go unaccepted, and he had to meet several doughty champions of the equipment he disparaged. He came out of the ordeal with credit, if not scatheless. Mr. Chas. Erith pointed out that it was unfair, in criticising the national electrification scheme, not to take into account the greatly reduced cost per kilowatt obtainable with modern large unit plant, while to contrast small internally-fired boilers working without condensing plant with the type of boiler employed in a large generating station with every facility for eliminating manual labour was foolish. Some of the discrepancies noted in the Paper were attributed unfairly to mechanical stokers, while it must in fairness be admitted that this type of plant resulted in labour-saving, a point of view that was also taken by Mr. A. W. Bennis. The latter speaker also made the good point that a lower grade fuel could be used with mechanical stokers than when hand firing was employed, and stated that as the author's tests were made directly after the armistice when everything was badly disorganised too much reliance should not be placed upon them. Mr. David Wilson and Mr. Patchell both took up the view that the mechanical stokers had been unnecessarily maligned by the author, who found his solitary supporter in Mr. Spyers, who thought that with good firing the efficiency obtained with hand firing would equal that obtained with the mechanical stoker. We are not at all certain that this statement does not reach the very heart of the problem, at any rate, so far as the smaller installations are concerned. In the larger plants in which electrical engineers are at present most interested, the question really resolves itself into a choice between a somewhat problematical loss in efficiency and a very real increase in labour costs. Mr. Brownlie, however, sticks to his point that mechanical stokers do not in most cases save labour, though they make labour easier. He pointed out that although many collieries were pleased with mechanical stokers, others were disgusted with it. And there, owing to the lateness of the hour, the matter had to be left. Mr. Brownlie is threatened by his opponents with a warm time when his Paper is discussed in Manchester, and as that part of the world is credited with the prophetic gift we shall presumably all of us hear shortly what form the steam-raising plant of the future is to take.

Industrial Lighting in Relation to Efficiency.

In a Paper on the above subject before the Royal Society of Arts on Wednesday in last week, Mr. L. Gaster recalled that seven years had elapsed since his last lecture before the society on a similar subject. He accordingly took up the subject from the point arrived at in the preceding Paper, and reviewed progress during the last seven years. A great deal of useful information was presented supporting the claims made for good industrial lighting on the ground of advantage as regards safety, health and efficiency, based largely on the evidence presented before the Departmental Committee on Lighting in Factories and Workshops, which reported in 1915. This report has rightly been regarded as a landmark in the progress of industrial lighting. Owing to the interference of the war the recommendations of this report, that there should be statutory power given in the Factory Acts to demand adequate lighting in factories, have not yet been carried into effect, which places this country, which has done so much pioneering work in this field, in a somewhat anomalous position, compared with some others. The United States, for example, being less affected by the war, has profited by our experience, and there are now six States which have definite legislative codes for industrial lighting. Mr. Gaster, therefore, expressed the hope that the lead formerly held by this country will soon be regained, a hope which all will share. Dr. T. M. Legge, H.M. Chief Medical Inspector of Factories, who opened the discussion, expressed himself in full sympathy with the views presented, and intimated that the desired requirement would be introduced into the Factory Acts in the near future. There is the further probability, also foreshadowed in the Paper, that ultimately there will be international action in regard to industrial lighting, and in this event we feel sure that Mr. Gaster will see to it that this country takes an important part in the work. We gather that experience in the United States has shown that manufacturers have readily acquiesced in the steps suggested to improve the lighting of their works. This is to be expected as we have here essentially a case for "government by consent."

Engineering and the Cape-Cairo Flights.

Electrical engineers who know full well the necessity for constant experiment in bringing a design to anything approaching perfection and for looking upon disappointments and failures as a part of the day's work will view with sympathy the developments of the technical side of aviation. In this they will be aided by a study of the flights which have recently been made across Africa in an attempt to establish an air route between Cairo and the Cape. It has been said that we learn more from our failures than from our successes, but there are certain cases where this is hardly true. Major Turner's account of his attempted flight from Cairo to the Cape on a Handley-Page machine fitted with a Rolls-Royce engine, which appears in last week's issue of "Aeronautics," shows that there are certain things which cannot be guarded against, however careful the design or construction. To engineers it will have seemed extraordinary that a test machine, as an aeroplane used in such a flight certainly is, and upon which, therefore, it may have been expected every care in its adjustment would have been expended, should break down after a comparatively short flight, even allowing for the arduous conditions. Major Turner gives a much-needed explanation of this failure. It was due, he points out, to two cases of deliberate tampering with the engine. At the time of the breakdown the engines had worked some 18 hours, while according to the Air Ministry regulations the Rolls-Royce engine may be flown for 200 hours between each complete overhaul, so that the engines employed had by no means reached anything like their test limit. The engine is therefore completely absolved from blame. To prove this to their satisfaction those of our readers who are interested in aeronautical problems cannot do better than refer to the critical article on the aero-engine which appears in the last issue of our contemporary. We congratulate Major Turner on his safe return, and wish him better luck on his next attempt. It is most deplorable that what is really a scientific experiment should be marred by such actions as those to which he has called attention.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

Mr. H. Cotton contributes an article on "A Method of Correlation as Applied to the Determination of Laws Followed by the Results of Experiments," in which he considers the best method of obtaining the correct straight line to establish a true relation between two experimental results (p. 368).

Dr. W. H. Eccles contributes an article on "The Theory of Antenna Resistance," in which he discusses certain theories put forward by Heaviside on this question (p. 370).

We describe the new electric signalling equipment at Victoria Station (London) of the South Eastern & Chatham Railway. Both signals and points are electrically operated, and an interesting feature is the three-position signal, which is now used for the first time in this country (p. 371).

On p. 374 we give an account of a Paper read by Mr. Leonard Milne before the Institution of Electrical Engineers last week on "The Electrical Equipment of Artisan Dwellings," together with an account of the discussion on this Paper.

On p. 376 we publish an abstract of the Report of the Earthing Sub-committee of the Institution of Electrical Engineers Wiring Rules Committee, which was presented and discussed at the Institution of Electrical Engineers last week.

Our Leading Article deals with a report on the Education of Electrical Apprentices which has recently been drawn up by a Committee of the British and Electrical Allied Manufacturers' Association, under the chairmanship of Mr. A. P. M. Fleming, C.B.E. (p. 379).

On p. 377 we give an account of a lecture delivered by Sir Joseph Thomson, O.M., P.R.S., before the Royal Institution on "The Work of the late Lord Rayleigh."

On p. 378 we give an abstract of the Annual Report of the British and Electrical Allied Manufacturers' Association.

Arrangements for the Week.

MONDAY, April 5th.

Institution of Electrical Engineers. Western Centre.

7 p.m. At the South Wales Institute of Engineers, Cardiff. Popular Lecture on "Thermionic Valves," by Prof. F. Bacon.

WEDNESDAY, April 7th.

Industrial League and Council.

7.30 p.m. At Central Hall, Westminster, London, S.W. Subject: "Results Achieved in Industry by Modern Methods," by Mr. J. F. Butterworth.

THURSDAY, April 8th

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. The University, Liverpool. Lecture on "Design of a 40-ton Titan Crane," by Messrs. P. A. Arberg and H. W. Mellor.

7.30 p.m. At the Grammar School, Chesterfield. Lecture on "The Destructive Distillation of Coal," by Mr. E. Nicholson.

FRIDAY, April 9th.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "The Development and Manufacture of the Thermionic Valve," by Mr. A. H. Howe.

The Method of Correlation as Applied to the Determination of Laws Followed by the Results of Experiment.

By H. COTTON, B.Sc., M.B.E.

In most experimental work measurements are made of two quantities, one of which is a function of the other. The experimental results are plotted on squared paper, and the nature of the function is determined from the curve obtained by the plotting. Whenever possible the curve is reduced to a straight line by assuming an equation for it, and then performing a mathematical operation upon the experimental results, for example by plotting the logs or some other function of the numerical results, the nature of the operation being suggested by the shape of the curve. When the new points obtained are seen to be on a straight line the assumed equation to the experimental results is proved to be correct, and its constants are at once determined from the equation of the straight line.

If all the points lie very nearly on a straight line then this can be drawn with a fair degree of accuracy, but if as very often happens there is a certain amount of irregularity, and it is only the grouping of the points as a whole that suggests a straight line, then it will be found that quite a number of straight lines can be drawn, each one of which seems reasonably to fit the points. There is obviously only one line which best represents the results of the experiment, and if the position of this is obtained merely by guess work considerable errors may be introduced into the final equation obtained to express the relationship between the variables of the experiment.

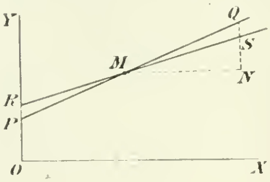

Fig. 1.

A consideration of two possible cases will make this clear Let x and y be the variables, and let the experimental curve be a straight line suggested by the equation

$$y = mx + c.$$

Let the points be so grouped that it is possible to draw two lines $PQ.RS$ each one of which seems to fit the points obtained by plotting y against x. (Fig. 1.)

Then for the line PQ $c = OP$ and $m = \frac{QN}{MN}$.

For the line RS $c = OR$ and $m = \frac{SN}{MN}$.

If the gradient of the line is large an error in the intercept C on the Y axis may not seriously affect the value of y because the error in y introduced by this error in c will be reduced on the ratio c to $(mx+c)$. And similarly with an error in the gradient.

Suppose now that the curve obtained by plotting y against x suggests an equation of the form

$$y = ax^n.$$

Taking logs we have

$$\log y = \log a + n \log x.$$

Hence the correctness or otherwise of the equation will be established by plotting $\log y$ against $\log x$ and noting whether the points so obtained lie along a straight line. When the line is drawn the intercept on the y axis will give the value of $\log a$ from which a can be immediately determined; and the gradient will give the value of n. Now an error in the intercept will be magnified when the antilog, *i.e.*, the value of a, is found. For example, suppose that it is possible to draw two straight lines as before, each of which seems to fit the points, and suppose that these intercepts are 1·0 and 1·02, a difference of 2 per cent. The antilog of these, namely, the corresponding values of a, are respectively 10·0 and 10·47, a difference of 4·7 per cent. Further, since the equation is of the form

$$y = ax^n$$

the error in y will be the same since a is here the coefficient of the power of x and not an added constant. An error in the determination of n will in this case be magnified since n is the power of x, and the greater the value of n the greater the error. Hence when the experimental curve suggests an equation in which the power of x is greater than unity the fixing of the position of the straight line requires a considerable amount of care.

If the experimental results are of such value that they justify the extra expenditure of time it is advisable to calculate the equation to the straight line by the method of correlation, since this method gives the best straight line for any given set of observations. As an illustration of the method, the results of a determination of the fusing currents of copper wires of different diameters are given in the Table. In the first two columns are the diameters and fusing currents. On plotting current against diameter a curve is obtained the equation to which is obviously of the form

$$C = Ad^n.$$

Logs are therefore taken and on plotting $\log C$ against $\log d$ the points come very closely on a straight line. The points are marked with a ring in the figure. The logs are given in columns three and four of the table, and at the foot of each column the total and mean is worked out. Columns five and six give the deviations of the individual values in columns two and three from the mean values. Columns seven and eight give the squares of these deviations and column nine the product of the deviations. The square roots of the mean values of the squares of the deviations are called the Standard Deviations. In this particular case we have for the standard deviations

$$\sigma_x^2 = \cdot 093 \therefore \sigma_x = \cdot 305$$
$$\sigma_y^2 = \cdot 221 \therefore \sigma_y = \cdot 470$$

a quantity called the "Correlation Coefficient" is determined from the expression

$$r = \frac{\Sigma (xy)}{n\sigma_x\sigma_y}$$

where n = No. of observations.

Its magnitude lies between the limits ±1 and the nearer it is to unity the more closely are the points grouped about the straight line. It is therefore a measure of (a) the accuracy of the observations, (b) the truth of the assumed law correcting the values of the two variables. In experimental work with any pretence to accuracy its value should certainly not be less than ·95 unless other quantities affecting the experimental results can not be kept constant. If such quantities can not be kept constant the results will hardly justify the trouble of working out by this method.

From the values given we have

$$n\sigma_x\sigma_y = 1 \cdot 75$$
$$\Sigma(xy) = 1 \cdot 71.$$

Table.

a millimetres.	c amperes.	Log a = X.	Log c = Y.	Deviations from means.		x^2.	y^2.	$\Sigma(xy)$.
				x.	y.			
0·110	3·65	0·9586	0·4843	−0·4990	−0·7521	0·249	0·5660	0·376
0·123	3·75	0·9101	0·5740	0·4505	0·6624	0·203	0·4390	0·298
0·190	6·85	0·7212	0·8357	0·2616	0·4007	0·0684	0·1606	0·106
0·231	9·15	0·6364	0·9614	0·1768	0·2750	0·0313	0·0758	0·049
0·272	11·65	0·5654	1·0664	0·1058	0·1700	0·0112	0·0289	0·018
0·309	13·75	0·5100	1·1383	0·0504	0·0981	0·00254	0·00962	0·005
0·369	18·75	0·4330	1·2729	+0·0266	+0·0365	0·00071	0·00133	0·001
0·415	23·0	0·3829	1·3617	0·0767	0·1253	0·00589	0·0157	0·010
0·557	34·5	0·2541	1·5378	0·2055	0·3014	0·0403	0·0907	0·062
0·707	49·6	0·1506	1·6955	0·3090	0·4591	0·0956	0·2105	0·142
0·910	68·3	0·0410	1·8344	0·4186	0·5980	0·175	0·3575	0·216
1·117	118·5	−0·0480	2·0738	0·5076	0·8374	0·238	0·7010	0·425
Totals	...	−5·5153	14·8362	...	...	1·1509	2·6567	$\Sigma(xy) = 1·709$
Means	...	$\bar{x} = -0·4596$	$\bar{y} = 1·2364$	...	...	$\sigma_x^2 = 0·093$	$\sigma_y^2 = 0·221$	

Hence correlation coefficient

$$r = \frac{1·75}{1·75} = 0·98.$$

Putting $Y = \log C$

$X = \log d$

$\bar{y} =$ mean of fourth column

$\bar{x} =$ mean of third column.

The equation to the straight line is

$$(Y - \bar{y}) = \frac{r\sigma_y}{\sigma_x}(X - \bar{x})$$

$$\therefore \quad \log c - 1·236 = 1·51 (\log d + ·16)$$

$$\log c = 1·51 \log d + 1·931$$

Hence $n = 1·51$

$a =$ antilog $1·931 = 85·31$.

In conclusion, it should be noted that this method does not eliminate errors of experiment, but it does make the best of any given set of observations, and prevents the introduction of further errors through a bad choice in the straight line. The line whose equation is worked out as above is that for which the error is the least. The theory of the method is appended.

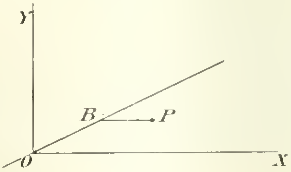

Fig. 2

Let the axes of co-ordinates be referred to the point $(\bar{x}, \bar{y})$ as origin. Then the straight line will pass through the origin and its equation will be of the form

$$X = kY.$$

Let $(x_1\, y_1)$ be the co-ordinates of any experimental point P. (Fig. 2.)
Then

$$(PB)^2 = x_1^2 - 2kx_1y_1 + k^2y_1^2.$$

The length PB is obviously the error in the X value of this particular point. For all the points the sum of the squares of the errors is therefore

$$\Sigma(PB^2) = \Sigma x_1^2 - 2k\Sigma(x_1y_1) + \Sigma(k^2y_1^2)$$
$$= n\sigma_x^2 - 2n\sigma_x\sigma_y kr + nk^2\sigma_y^2$$
$$= n(\sigma_x^2 - 2k\sigma_x\sigma_y r + k^2\sigma_y^2)$$

Where $$r = \frac{\Sigma(x_1y_1)}{n\sigma_x\sigma_y}$$

and r, n, σ_x and σ_y have the same meaning as before. Differentiating the above expression for $\Sigma(PB^2)$ with respect to k and equating to zero, we have for the minimum value of k

$$-2\sigma_x\sigma_y r + 2k\sigma_y^2 = O.$$

Therefore $$k = \frac{\sigma_x}{\sigma_y}\,.\,r.$$

Hence the straight line for which the mean square of the errors in the X values is a minimum is

$$X = \frac{\sigma_x r}{\sigma_y}\,.\,Y.$$

Referred to axes through the origin this becomes

$$(X - \bar{x}) = \frac{\sigma_x r}{\sigma_y}(Y - \bar{y}).$$

Similarly the equation to the straight line which makes the mean square of the errors in Y a minimum is

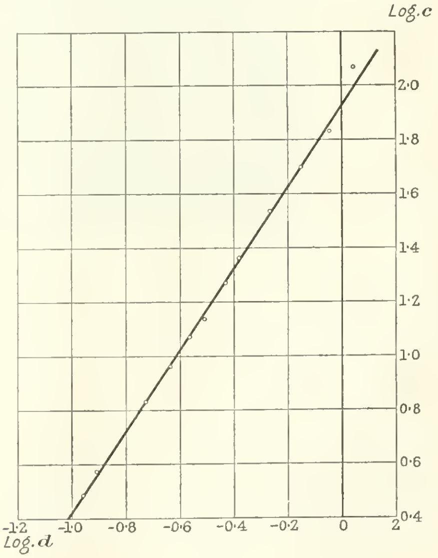

Fig. 3

$$(Y - \bar{y}) = \frac{\sigma_y r}{\sigma_x}(X - \bar{x}).$$

It is this equation which was used in the preceding calculations since it was decided to find a function of x from which the corresponding y value could be calculated.

Theory of Antenna Resistance.

By W. H. ECCLES, D.Sc.

In the first volume of his "Electromagnetic Theory," Heaviside describes the manner in which the Faraday lines belonging to an electric charge are detached as radiation when the charge moves to and fro on a simple vertical antenna with the speed of electric waves. From his reasoning we see that all the parts of the Faraday lines accompanying the charge on its upward motion continue their outward motion after the charge has reversed its velocity and started down the antenna. We may also conclude that when the speed of the charge is less than that of electric waves, and is not reversed with infinite abruptness at the top of the wire, then only a fraction of the Faraday lines is detached. It follows from formulæ for radiation that this fraction diminishes as the speed of the moving charge diminishes, that is to say, as the frequency of the oscillations of the antenna diminishes and that the fraction is, in fact, proportional to the frequency as a first approximation, even when the charge has the distributed character inevitable in practice. The fraction of the moving Faraday lines which does not return into the antenna accounts for the energy spent in radiation; the remainder of the lines move to and fro, and accounts for the waste of energy in the ohmic resistance of the ground and conductors, and in the dielectric losses of the insulators and masts. It is as if one component of the whole antenna current might be regarded as completely occupied in supplying Faraday lines that are continuously detached while the remainder is occupied with the losses just enumerated. Of course, some part of the energy of the lines detached is also wasted in the neighbourhood of the antenna; but this, though of importance to the distant receiving station, must not be treated as additional to the portions already counted it is already included in the energy initially given to the lines detached. We shall assume in what follows that the ohmic and dielectric losses are independent of the frequency of the oscillations, and that they do not cause any phase displacements.

Let an oscillatory current of constant magnitude I be supposed running in an antenna; this current I may be divided into two portions, i and j, which are in phase, so that $I = i + j$. Let the portion i be devoted to heating the conductors and non-conductors of (and about) the antenna, and the portion j be concerned with the emission from the antenna as radiation. The portion j is a larger fraction of the whole current at high frequencies than at low frequencies, and j/I may be taken to vary approximately as the first power of the frequency f. We therefore write

$$j/I = af,$$

where a is independent of frequency and magnitude of current. The power consumed is divisible into two portions namely, that spent in joulean heating and that spent in radiation a statement which may be written in the forms

$$\begin{aligned}P &= ri^2 + mj^2\\ &= r(I - j)^2 + mj^2\\ &= \{rI^2 - 2rIj + (r + m)j^2\}\\ &= \{r - 2raf + (r + m)a^2f^2\} I^2,\end{aligned}$$

in virtue of the preceding equations. But the power consumed is equal to the antenna resistance R multiplied by the square of the antenna current, and therefore the bracketed quantity in the last equation is the antenna resistance. This may be written

$$R = \left\{af\sqrt{(r+m)} - \frac{r}{\sqrt{(r+m)}}\right\}^2 + \frac{rm}{r+m}.$$

This is a minimum when

$$af = \frac{r}{r+m}$$

and then

$$R_m = \frac{rm}{r+m}.$$

When values of R and f are taken as ordinates and abscissæ, we obtain a parabola, as shown in Fig. 1. The equation for P also indicates that $R = r$ at two values of f given by the equation

$$0 = af\{(r+m)af - 2r\},$$

that is, when $af = 0$

and $af = \dfrac{2r}{r+m}$.

The latter value of f may be designated f_0, so that

$$f_0 = \frac{2r}{a(r+m)},$$

and therefore

$$\frac{R-r}{r} = 2af\left(\frac{f}{f_0} - 1\right),$$

whence, putting $f = s/\lambda$, where s is the speed of electric waves, and $f_0 = s/\lambda_0$, we obtain

$$\begin{aligned}\frac{R-r}{r} &= 2as\frac{\lambda_0 - \lambda}{\lambda^2}\\ &= b\lambda_0\frac{\lambda_0 - \lambda}{\lambda^2},\end{aligned}$$

where b is a numeric.

This simple analysis cannot hold strictly down to wave-lengths so short as the natural wave-length of the antenna, because by taking the quantity a as a constant the distribution of current on the antenna has been assumed invariable through all changes of frequency, which is not the case.

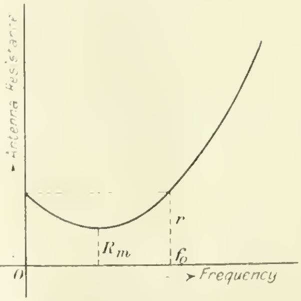

FIG. 1. ANTENNA RESISTANCE AS A FUNCTION OF FREQUENCY.
Note that when the curve is drawn with wavelengths as abscissæ it takes the shape shown in Fig. 57, p. 129, of the "Handbook."

Those interested in the subject of the effect of current distribution upon the form of the radiation field may consult a Paper by B. van der Pol in the "Proceedings" of the Physical Society, June, 1917, where some remarkable diagrams of the field are given, though radiation resistance is not there discussed. For wave-lengths shorter than the fundamental our equation cannot be given much weight; but for longer wave-lengths it accords fairly well with experiment. As a rule the published measurements of antenna resistance give insufficient data concerning, for example, the h.f. resistance of the loading coils used for altering the wave-length during the observations, and therefore it is not possible to make an adequate comparison of the theory with experiment. In consequence, the writer assumed in the first and second editions of his "Handbook" (at p. 130 in the second edition) that the quantity λ_0 in the above equations represents the natural wave-length, and that r is equal to R_0, the resistance at the natural wave-length, and also that $b = 3$; these values fitted some of the available data reasonably well. But if these assumptions be not made a better fit can be made to a curve. For example, the curve of Fig. 59 at p. 131 in the "Handbook" is fitted well by taking the round figures

$$\lambda_0 = 600, \quad r = 5{\cdot}0 \text{ and } b = 2{\cdot}0.$$

Electric Signalling at Victoria Station.

A New 3-Position System at Work.

The signals usually employed on the railway systems of this country consist of semaphore arms, which work in the lower left-hand quadrant. The operation of this arm is generally effected purely by mechanical means from a signal box, though there are an increasing number of installations where electric or electro-pneumatic power is employed to reduce the labour of the signalman. The introduction of track circuiting, and a desire to relieve the signalman of certain mental responsibilities at busy railway centres, are also factors which have assisted the introduction of automatic apparatus.

The signalling system recently installed at the Victoria Station of the South Eastern & Chatham Railway in London goes a step further. In the first place the signal arms operate in the upper left-hand quadrant, and have three instead of two positions. A new position is provided for arresting the arm at 45 deg., which indication shows the driver that he may proceed slowly. This re-arrangement of the signalling installation has also permitted the concentration of all the operating mechanism at that terminus in one signal box. The result is a decided improvement in running the trains in and out of the station and a possibility of further additional simultaneous movements of trains and engines being effected without danger. For this to have been done with ordinary mechanical signalling would have involved considerable alterations to the then existing system, and as this was in need of renewal the opportunity was taken of entering into a contract with the British Power Railway Signal Co. to carry out a three-position installation on the lines we have just mentioned.

To give some idea of the problem involved, it may be noted that the number of train and shunting movements in the station for 24 hours amounts to about 650.

The New Signal Cabin.

The new signal cabin replaces two cabins of the old type. It contains one interlocking frame for the operation and control of the points and signals, this frame superseding the two manual operating frames used in the old installation. The frame is equipped with 200 levers, 107 of which work signal indicators and releases, 47 points, two scotch blocks, one a bolt block, while 43 are spare. The unit lever system is employed—that is, one lever is used for each function. For instance, in the case of a cross-over road there are two lever slides, one for each end of the cross-over. To avoid complication, however, these slides are coupled together, and are operated by one lever handle. A departure has also been made from the usual practice of metal plated lever handles, black enamel having been substituted. To distinguish between the functions of various levers the horizontal parts of the casting are coloured red for signal levers, black for point levers, while those having special functions, such as the bolt locking lever, are coloured blue in accordance with the usual practice of the South Eastern & Chatham Railway. Above each lever is mounted a combined electric lamp case and number plate, which is placed at an angle rendering it easily visible to the person operating the levers. This lamp is used in conjunction with the electric locking, and gives an indication by lighting up as to whether the lever may be moved or not.

The Power System.

The whole of the signalling and point system is operated by direct current, the points and signals being supplied at 110 volts, and the track circuit system at 12 volts. All the roads are equipped with track circuits, whose functions are to control the locks on the signal and point levers through a relay system. They also automatically replace signals in the stop position and facing point lock bars are eliminated route and section locking being substituted.

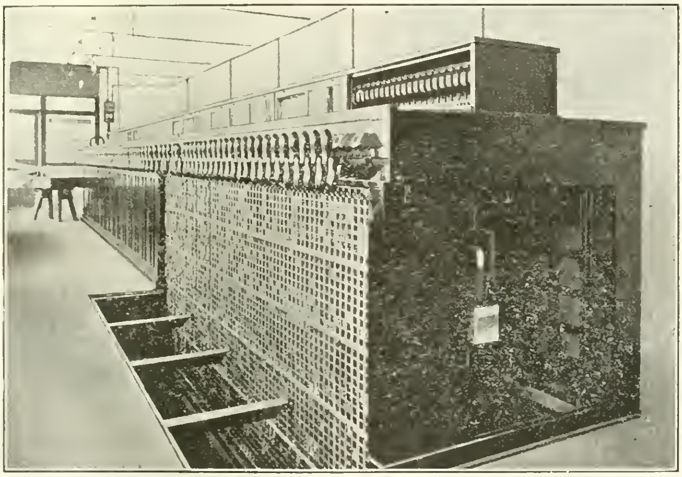

Fig. 1.—View of the Interlocking Frame at Victoria.

The power house is a single storey building adjacent to the signal box itself. It is divided into two parts, in one of which the batteries are installed, this being partitioned off from the remainder by air-tight doors, in order that the fumes shall not affect the switchboard or generating plant. Direct current at 400 volts is obtained from the mains of the Westminster Electric Supply Corpn., and this drives two motor-generators which are available for either charging the batteries or for supplying current at 110 and 10 volts respectively direct to the interlocking frame and signal and point motors, or to the track circuit switchboard. One of these motor-generators has an output of 7½ h.p. at 165 to 100 volts, and is primarily used for charging the Tudor battery which operates the power circuits. The other has the same output, and supplies current at 35 to 10 volts for charging the track circuit accumulators and operating the low tension auxiliary circuits such as locks, indicators, &c.

In order to ensure that there will be an adequate supply of power should for any reason the public supply fail a stand-by set, consisting of a 14 h.p. Pelapone gas engine, running at 850 revs. per min., and coupled to two generators, is provided. One of these generators supplies current at 165 to 100 volts, and the other at 35 to 10 volts for the purposes mentioned above. The battery room contains two batteries, one of 60 cells with a capacity of 350 ampere-hours for power purposes, and the other of 12 cells, with a capacity of 800 ampere-hours, for the track and auxiliary circuits. The former is,

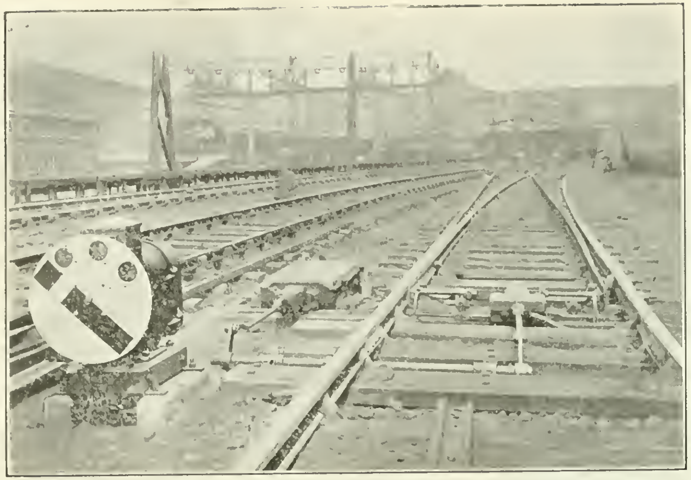

Fig. 2.—Dwarf Signal at 45 deg. Also showing Point Operating Mechanism.

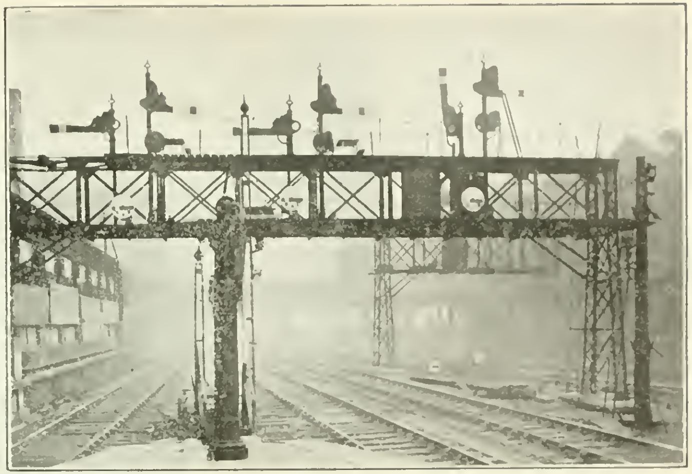

Fig. 3.—Gantry showing Platform Starting Signals and Inner Up Stop Signals.

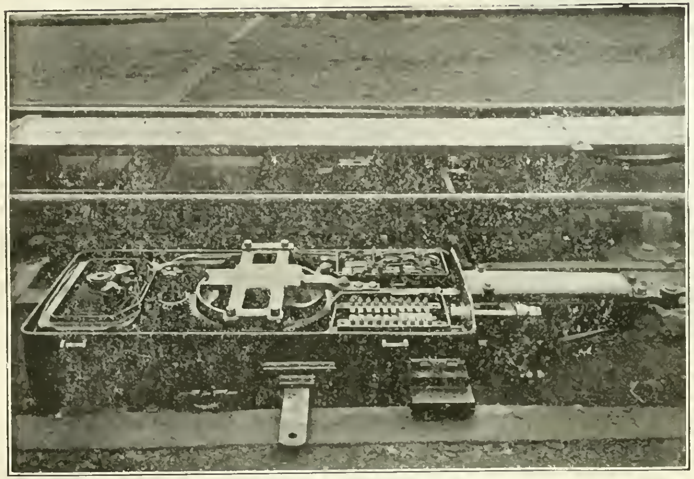

Fig. 4.—Point Mechanism with the Cover of the Case Removed.

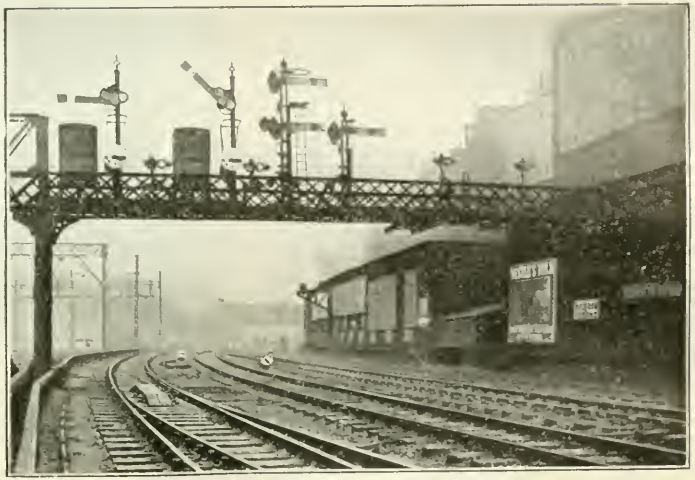

Fig. 5.—Gantry showing Three-position Arm at 45 deg.

of course, only an intermittent supply, while the latter is constant in demand, except when the track circuit is short-circuited by a vehicle.

The Lever Mechanism.

Turning to the switch lever mechanism, each lever is provided with a cam slot by means of which intermittent motion is transmitted to a tappet bar. In the preliminary movement of the lever to its half-way position, the locking tappet is moved through one half of its stroke. This movement locks all the levers which would conflict with the new position of the lever in question, but no change is made in the operating circuits. The signal, or point motor, however, is switched in, and operates as explained below. When the movement of the point or signal is finished the "dynamic action" effects the release of the lever, and permits its movement to its final position, thereby unlocking all the levers which do not conflict with the new position of the operating lever.

The lever is prevented from completing its stroke by a latch and lock mechanism, which is released electrically by the dynamic current, and the fact that it is possible to move it into its final position is an indication that the point or signal has operated properly. The movement of the lever from the reverse to normal position is performed in a similar way in the case of the point lever, with the sole modification in the case of the signal lever that no electrical indication is required during the reverse movement. This mechanical locking ensures that before a signal can be given over any route that all points are in their proper positions and locked in that position, and that all opposing signals are in the "stop" position. No change can be made in the position of any of these points or signals until the lever controlling the signal displayed at "proceed" has been replaced in its proper normal position.

The Point and Signal Mechanism.

The point mechanism is shown in Fig. 4. It is designed with all its operating parts in one case, thus affording complete protection against the weather. At Victoria this mechanism is arranged in the six-foot way. The motor through the medium of the train of gears drives a cam gear from which the various parts of the machine are operated. The details of the operation are as follows: When the motor is switched on the locking bar is raised and the points are unlocked. They are moved, locked in their new position, and the locking bar again lowered. Finally the current is cut off the motor, which is reversed, so that it is properly connected for the reverse movement. The motor is now on a closed circuit, which includes the "indication magnet." The momentum acquired during the point-shifting operation enables the motor armature to revolve for several revolutions, and the current generated by these revolutions energises the "indication magnet," and permits the final movement of the lever mentioned above to be completed. The changes in the motor connections at the end of the operation are effected by the mechanical shifting of a contact block in the pole changer. This contact block is under the control of two sets of solenoid magnets, so should the switch fail to complete its movement, the controlling lever may be shifted, thus energising one set of the magnets, and causing pole changes to operate the points in the appropriate direction. This arrangement is of great use when the points are blocked with snow or ice, as it enables them to be worked backwards and forwards so that the obstruction may be dislodged. It should be mentioned that the cam gear in the operating mechanism is designed to permit a free run of the motor at the beginning and end of the operation, while a friction clutch with large surfaces and lined with fibre is provided to protect the mechanism from shock should its movements be obstructed.

Turning to the signal, which is also motor-operated, when the lever is moved the motor starts up in the same way as described for the point mechanism, and raises the signal from the stop to the 45 deg. position. Upon the completion of this movement the operating circuit is opened and the holding circuit is closed, thus connecting the holding field of the motor in series with the operating field and armature. The design of the pole-pieces on which the holding field windings are mounted is such that the magnetic flux thrown across the air-gap between the motor armature and the pole-pieces magnetically locks the armature against rotation, and thereby retains the signal arm in the desired position so long as the circuit is intact.

When the signal lever is placed in its normal indication position energy is cut off from the motor and the signal arm returns by gravity to the stop position, thus causing the gearing and motor armature to move backwards to their original position. Just before the signal arm reaches the stop position the contacts in the motor-circuit are reversed, so as to be ready for further operation, while the effect of the dynamic current allows the controlling lever to be released and restored to its normal position. This has the further advantage that the speed of the returning mechanism is checked and brought to rest without shock.

The operation of the signal from the 45 deg. to 90 deg. position is dependent upon the position of the signal in advance. A signal is held in the 90 deg. position through the medium of holding fields in the same manner as described above. The return from the 90 deg. position to the normal is also effected by gravity, but if it is decided to check the signal in the 45 deg. position a momentary current is caused to flow in the motor winding and the mechanism is thereby brought to rest.

The signals operated by this means at Victoria are of the ordinary semaphore and also of the dwarf type. Examples of the former are shown in Figs. 3 and 5, Fig. 5 showing one of the semaphore arms in the 45 deg. position, while the other illustration shows the signal in the 90 deg. position. The dwarf signal is shown in Fig. 2, which also gives a good idea of the general arrangement of the point operating mechanism.

The Advantages of the System

The benefits to be derived from the use of such a system as this in a busy station like Victoria are considerable. In the first place the number of signals is considerably reduced, as practically each signal is at once a home and a distant signal. This means that there is a smaller number of mechanisms to be maintained. There is the further advantage that the three-position method conveys a more definite instruction to the driver than do the usual indications. This particularly applies to the dwarf or shunt signals, as the signalman can move the arm to the 45 deg. position and the 90 deg. position follows if the track circuit which it covers is unoccupied, and the signal immediately ahead is in the 45 deg. or 90 deg position. The result is a greater confidence is established, and more accurate working is obtained.

For shunting purposes the three-position signal presents especial advantages. For instance, in ordinary two-position signalling the driver would receive the same signal aspect in connection with adding a horse-box or other vehicle as he would for shunting to the next signal, whether near or far. Again, whilst the 90 deg. position is the equivalent to the shunt forward signal in ordinary two-position signalling, it could never be given to a driver to enter an occupied section or a dead-end, as this position is governed by the track circuit and the signal immediately in advance of it. A driver receiving this signal is assured that he is entering a section of line which is unobstructed at least two signal sections ahead, and this must have the effect of giving him greater confidence and tend to the shunting work being carried out more expeditiously.

As noted above, both running and shunting signals, the 45 deg. position is governed by the lever movement, and the 90 deg. position is automatically given when trains are approaching routes that are unoccupied ahead, and the signal ahead is either in the 45 deg. or 90 deg. position. The running signals are replaced to danger by the track circuits as soon as a train passes the signal, but shunting signals are not controlled by the track circuit for their 45 deg. position. When these three-position signals are in operation at night-time a red light (horizontal position of the arm) indicates "stop," a yellow light (the 45 deg. position) indicates "Proceed, but be prepared to stop at next signal," and a green light (the 90 deg. position) indicates "All clear; next signal is off." In the case of the shunting (disc) signals the same coloured lights are used at night to indicate the corresponding positions.

We have to thank Mr. P. C. Tempest, chief engineer and now general manager to the South Eastern & Chatham Railway, for permission to publish an article on this subject, and our acknowledgments are also due to the British Power Signal Company for certain details of this interesting mechanism. The half-tone illustrations which accompany this article are published by the courtesy of the "Railway Gazette."

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Talks with Workers on Wealth, Wages and Production." (London: Sir Isaac Pitman & Sons.) Pp. viii.+124. 2s. net.

"Science and Theology." By F. W. Westaway. (London: Blackie & Son.) Pp. xiv.+346. 15s. net.

"Radio Engineering Principles." By H. Lauer, B.S., and H. L. Brown, B.E.E. (London: Hill Publishing Company.) Pp. xv.+300. 21s. net.

"Modern Illuminants and Illuminating Engineering," by L. Gaster and J. S. Dow, 2nd Ed. (London: Sir Isaac Pitman & Sons.) Pp. xv.+490. 21s. net.

"The Practical Electrician's Pocket Book and Diary, 1920." (London: S. Rentell & Company.) Pp. lxxii.+520. 2s. 6d. net.

"The Propagation of Electric Currents in Telephone and Telegraph Conductors," by J. A. Fleming, M.A., F.R.S. (London: Constable & Co.) Pp. xiv.+370. 21s. net.

The Electrical Equipment of Artisan Dwellings.*

By LEONARD MILNE.

If electricity is to be employed in the artisan dwellings which are projected under the Government Housing Scheme, it is essential that the installation costs should be very much reduced. On the average, the house contemplated would require nine lighting points and the following are estimates for the internal installation work on various methods at present in vogue†:—

Cost of 9-light installation in screwed enamelled welded tube with 600-megohm grade C.M.A. cable of sizes conforming to the requirements of the Institution, including main switch and main fuses, distribution board, plain fittings, lamps, and switches....	£19	13	8
The same in close-joint conduit with continuity fittings ...	14	1	6
The same in wood casing...	16	3	0
The same with wires carried on porcelain cleats and unprotected except where they rise through floors and pass through walls	11	4	8

As regards possible savings a main switch could well be eliminated by substituting two replacement fuses. In nine cases out of ten a small main switch is so corroded and jammed with dust and dirt that it cannot be removed without breaking. A replacement fuse can be pulled off with certainty, and if it is put in, even with all lights on, no harm will happen.

It seems some form of uncased cleat wiring must be used, on the grounds of economy. A very large amount of work was carried out on this system for the War Office during the war, and the late Colonel Seaman, then Chief Electrical Engineer of the War Office, informed me that, although he had seen much of such work carried out in the worst possible manner, he had never traced any fire or accident happening therefrom.

It is quite unnecessary to use such costly material as 600-megohm grade cable on the neutral side of systems directly and permanently connected to earth, since at the outside the insulation of the braiding and of the porcelain cleat would be amply sufficient, while experience shows the fire risk is small.

Wiring.

At the present time a No. 18 S.W.G. is the smallest wire permitted by the Wiring Rules. In the case of twin wires the minimum size permitted should be reduced from No. 18 to No. 20 S.W.G., since the mechanical strength of a twin 20 S.W.G. wire is at least equal to the mechanical strength of a single 18 S.W.G. A twin wire might be used, made up with one core of No. 20 S.W.G. insulated to 600-megohm grade with a bare No. 20 S.W.G. laid in long spirals around this, and the whole braided. Such a twin conductor, compared with two seperate conductors of No. 18 gauge, effects a saving of 50 per cent. in the cost of wire, and is amply large enough to carry the current required at a pressure not less than 200 volts

The saving due to the employment of twin wires is, however, with short runs, more than lost in labour and waste of material where switch drops are brought down to hand level.

The switch drops may be replaced by a combined switch and ceiling rose on the wall near the ceiling level, and operated the switch by a cord or rod attachment. From this ceiling rose, a twin flexible wire, passed over an insulated hook, should be run directly to the point where light is required. This twin flexible should consist of one insulated wire and one semi-insulated wire. In this way a saving of 40 per cent. would be effected in the cost of flexible cords. Incidentally, the arrangement proposed has the advantage of practically insuring branch switches being placed on the live side of the system—a point which I have frequently found neglected on otherwise well-executed installations, while a single wire run on porcelain cleats is much less conspicuous than the usual two or three wires run side by side on multiple cleats. Where conductors run of necessity through floors, they should be protected up to the skirting level or possibly above hand reach, preferably in $\frac{3}{8}$ in. insulating tube. They should also be protected in a similar manner where passing through walls. The total result of the economies suggested is that the cost of a 9-light installation would amount to £7, as against from £19 13s. 8d. to £11 4s. 8d. for the cost of a similar installation on the recognised methods.

Services and Tariffs.

It is of importance that the capital cost of services be materially reduced, and it is suggested that the supply from house to house of the group should be made by means of bare overhead wires carried on insulators attached to the chimneys of the buildings, and that the supply should enter at the top of the house and not at the bottom, the supply authority's apparatus being fixed on the upper floor instead of on the lower floor. This arrangement has the further advantage of providing the driest position for fixing the supply authority's apparatus. Where lighting only is installed consumers might be charged a fixed annual rate and a meter eliminated.

The objections to such a fixed charge under a contract for lighting only is that it leads to extravagant consumption and to the dishonest use of lighting points for electric kettles, irons, and all the various appliances which can be utilized with a lamp-socket adapter; or, on the other hand, to the use of electricity for domestic purposes other than lighting being hampered. The method has been tried in two small agricultural towns of a very similar size and character with results varying in a remarkable way. In the one case the annual consumption worked out on the average to 31 units per 40-watt lamp installed. In the other case the annual consumption worked out at 46 units per annum per lamp installed. On investigation it was found that there were a very large number of kettles, irons, &c., used in the town, the current for which was not paid for; and, in fact, as a method of promoting the sale of domestic appliances I would commend this system of charging for the consideration of the Electrical Development Association.

This difficulty could be met by installing one meter for every dozen or 20 houses, charging a fixed rental sufficient to cover the most extravagant use of current for lighting purposes, and allowing a quarterly rebate to each consumer when the meter reading showed a consumption below the predetermined estimated figure.

Supply for all Purposes Essential.

It is highly desirable that a supply of electricity should be available for all purposes. This necessitates that the anticipated revenue would be sufficient to justify this expenditure. As regards heating, the elimination of fires from the room where heat is constantly required cannot be anticipated. But in bedrooms, where artificial heat is only required in case of sickness and on rare occasions, electric stoves are eminently suitable By substituting for chimneys and grates efficient forms of ventilation in all rooms, but living rooms, would save £25 per house and would further provide an additional 15 sq. ft. of floor-space. The cost of wiring with twin wires for the heating plug would only amount to approximately 18s. per point. Electric stoves and other electrical apparatus should be available on the estate for hire by the tenants.

It will pay the electricity supply undertaking to quote preferential rates for cooking in an artisan dwelling, since the range will be used chiefly for the midday-dinner at or near the time of minimum daytime load on the station.

The Hot Water Supply.

The stumbling block to electrical cooking, however, is the question of domestic hot-water supply. Separate anthracite stoves or gas-heated geysers are costly, and the heat losses with unlagged cisterns and pipes are high. The question of the electrical heating of water for domestic supply merits more investigation and consideration than it has yet received. There are several electric water-heaters on the market for which an efficiency of 90 per cent. or over is claimed when the apparatus is used to its full capacity over a period of 24 hours. It appears essential that some form of thermal storage be employed if electric heating of water is adopted. To give a convenient supply of bath water, 18 gallons of water at a temperature of 104° F. should be available within 10 minutes; and to provide this without thermal storage, even with a heater of 100 per cent. efficiency and assuming a temperature of 55° F. for the inflowing cold water, would require over 15 kw. for 10 minutes. With arrangements which would ensure that the water-heater load was off at times of peak load a rate of $\frac{3}{4}$d. per unit or less should be quoted for this service. This works out at just over 6d. a day.

The objections to thermal storage by means of the heated cast-iron block are the weight and bulkiness of the apparatus. The objection to thermal storage in the hot water itself is that either a large cistern is required for adequate storage, or that the water has to be stored at a high temperature, increasing the thermal losses and, moreover, rendering the water unpotable and liable to deposit scale. Water at a boiling temperature should be available in small quantities, a somewhat larger quantity at about 130° F., and a copious supply at 104° F.

Although a domestic hot-water supply may be obtained more cheaply electrically than in any other way the price is still high for an artisan family. The direction in which the final solution of the problem lies is to fit a small boiler in the parlour grate, to store tepid water at, say, 80° F. or 90° F. in winter time, and to employ what may be called an electro-thermic booster to raise the tepid water to the required temperature.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

† All estimates in this Paper are based on the prices ruling in the autumn of 1919 and the sizes of wires then in common use. Increases in the cost of labour and material and recent variations in the sizes of wires do not, however, materially alter the comparative figures.

The solution of the hot water problem is the key to the extensive introduction of electric cooking. Leaving out of consideration the provision of a hot water supply, the capital cost of the complete electrical equipment of an artisan's dwelling, including cooking apparatus, is practically covered by the saving on the building by dispensing with chimneys and grates. The introduction and wide distribution of cheap electrical power in artisans' dwellings may, to a large extent, revivify cottage industries, and the coming generation will see women and elder children again working in their homes instead of crowding to the factory, to the great social advantage of the community.

This Paper and the Report of the Earthing Sub-Committee of the Wiring Rules Committee, an abstract of which will be found on page 376, were discussed together at the meeting of the Institution last week. We give below an account of the remarks of the various speakers.

Mr. J. W. Beauchamp said there was a good deal of diversity of opinion in fixing reasonable prices. Some contractors put forward prices for the "cheaper" systems much greater than one would expect to pay for tube systems. More money should be spent in the factory and less on the work in the buildings, the cable and fittings must be got ready and handed to the wireman so that he would merely have to nail them up. Mr. Milne's figures for cost varied from 3 to 1 per cent. on a £700 house. Even if there were a difficulty in getting heating and cooking in, they should be prepared to spend a good deal of money to get electric light into these workmen's dwellings. Assuming that only a quarter of a million of the proposed houses were within the reach of electricity supply, that meant about 2½ millions of money for electrical contractors, while the supply of energy, lamp renewals, &c., must also represent very large business. Whether they got this business depended upon the people who had its giving out, *i.e.*, members of local authorities, architects and surveyors, who had to be converted and educated—taught that electricity meant a cleaner house, cheaper upkeep and probably a higher economic rent. The rent-paying power of the workmen to-day had, perhaps, not been fully explored. As time went on they would probably get simpler tariffs, cheaper cooking apparatus, and the meter problem would be solved partly by 24-hour supply and partly by the use of waste heat from generating stations.

Mr. G. Scott Ram (H.M. Electrical Inspector of Factories) gave an account of the genesis of the Earthing Sub-Committee. They had experimented with earth wires of the sizes given in the Institution rules and found they got much too hot. The temperature that the wire reached indicated the maximum current it should carry and the time it should carry it. That was limited by the existing regulations as regarded fuses. Anything under double the working current was permitted for an unlimited time. It was found under those conditions the earth wires would get hotter than was prescribed in another of the rules. One suggestion given in the Report was that the margin on fuses should be reduced. If that were done, the existing sizes of the conductors could remain, and, assuming that that method would be adopted, the corresponding size of earth wires had been worked out.

Mr. H. H. Berry said he was entirely in favour of Mr. Milne's encased cleat wire. The Wiring Rules Committee would welcome any suggestions from members. The rule that adequate double-pole switching on the heating circuits in connection with the heating installations in the ordinary home must be used was practically never observed, and therefore the Committee considered it very necessary to strengthen their rules by eliminating clauses which were not adopted or by modifying them so that the Insurance Companies would enforce them. The reason it was not practicable to install a double-pole switch with a greater carrying capacity than 2 kw. on every heater in a room was that there was not such a thing on the market. This meant that the rules were disregarded. An adaptor was being designed which would limit the apparatus used with it to a certain capacity. The avoiding of two meters was most desirable. As regards hot-water supply, electricity should be used to "top up" the temperature of water received from a communal source. He used hot water to keep his electric cooker hot, so that he merely had to heat up something which had been in the hot storage cupboard, reducing the current considerably and also the time taken to complete the cooking.

Mr. J. Frith said the meter question in artisan's dwellings could be solved by the use of a maximum demand meter. The main thing on which the Earthing Sub-Committee's Report stood or fell was the statement that the earthing wire was there primarily to open the circuit in case of a fault. It had, therefore, to carry the current which blew the fuse or tripped the breaker and to prevent the carcases of motors, switchgear, &c., becoming alive. The Institution rules regarding the carrying capacity of cables and fuses were incompatible. Copper was not the right metal to use. The conditions laid down meant a large earth wire, but that was better than a fused earth wire.

Mr. W. R. Rawlings did not like the open wire or cleat system. He was surprised that Mr. Milne had not referred to systems solid in character though low in price, such as Henley's, Callender's, Stannos, and the Fixed Price Light System, which last would overcome many of the difficulties the author referred to. In the early days he (Mr. Rawlings) had done a fair amount of work in introducting lights into houses free of initial charge. That made work for the contractor and for the supply. The Fixed Price Light Company eliminated all main switches and meters, and used one service for each block of houses. They took a single Stannos wire along the face or rear of the building, made a T joint using a single wire, using the outer as a return. Inside the building a single-pole switch was fixed from which the necessary number of lights were run. Such a system could only be adopted on the alternating-current system, and they put in a separate wound transformer for each group of houses. The Earthing Sub-Committee recommended that the fuse should be reduced to a 50 per cent. overload. He was not sure that that was sufficient margin.

Mr. H. J. Cash said if the wiring must be got into the artisans' dwellings at all costs it was far better to cut down the cost of the installation than to spend large sums on propaganda work. He agreed with Mr. Rawlings that open wiring should be avoided in artisans' dwellings if possible, but with Mr. Milne's system with horizontal runs under the floors and cleats half-way down the wall and boring through the joists, there would practically be no open wiring. The switch ceiling rose should be rapidly developed, though it might not at present have the same life as the tumbler switch, which was now reaching perfection. Half the cost of the wiring part of the installation was due to the switch drop. It should be as near the light point as possible. If a cheap service had to be provided one was up against the difficulty that the heating load must be carried on the same wire. Electric hot water heating could only be done economically on a large scale. Electrically heated airing cupboards had generally been overlooked, though it was the most economical form to use. Many artisans would be skilled enough to replace the fixed price lampholder by one of their own.

Mr. W. Cross said on a system with which he was connected he had found a pressure of 50 volts between the neutral and the earth. The cost of a 9-light installation as given by Mr. Milne seemed optimistically low. The cost of switches, branches fittings, lamps and shades would be at least £4 or £3. 10s., omitting the main switch. The metal-covered wire system was worth consideration. He did not like the idea of cleats in artisan's dwellings. Mains could be run through the false roof in a row of houses, which would reduce the cost of the service. He favoured a separate meter for each consumer. It need not cost more than 45s. There might be a difficulty in making a fixed charge, plus a fixed sum per unit, but one might find a rateable value basis which would be satisfactory. With regard to water heating, he believed central heating might be the best. Neither gas nor electricity was economical for heating water at present. With regard to the Earthing Sub-Committee's Report, most of the faults occurred at the joints or connections to apparatus The fuse wires should not be rated so that they only blew at 50 per cent. of the working load. That practically meant the fuse was not calculated on the conductor, but on the apparatus it protected. In many cases, especially with motor loads, the current at switching on was considerably more than the full load current. He did not think it was desirable to reduce the permissible fusing current compared with the working current. He thought the table proved that copper was quite satisfactory for a fuse wire. It was an advantage that the fuse should get hot at little more than the normal load.

Mr. S. Pooley said cheap wiring had to come, and soon. He was favourably disposed to the cleat system, because there was so much cheap wire on the market that the more one had it in evidence the better chance one had of looking after the troubles it caused. He did not altogether like this semi-insulation, as one could not always depend upon getting the uninsulated wire on the neutral side. A rotary switch with a cord pulling always in the same direction might be useful.

Mr. P. Rosling remarked that the metal-covered twin wiring system carried out the requirement that it should be worked out in the factory so that it could be put up quickly. It could be installed at just a little higher price than the open cleat system, and if switches and so on were eliminated in some of the other systems they would come down too. The cost of the double wire metal-covered system before the war was about 15s. a point. That had now gone up to 25s. or 26s. There must be tens of thousands of artizans' dwellings now wired with that metal system, and the upkeep and maintenance were practically nil. He protested against the discontinuance of copper wire for fuses. They had served their purpose well, anyway in the smaller sizes, and they had not heard of many accidents due to them. Tests in a 10-ampere fuse box showed that the tin-covered wire would carry the 10 amperes continuously and would blow in two minutes with 15 amperes.

Mr. J. H. Elliott said something like an ordinary ⅜ in. gas tap could be used as a switch. Hitherto it had been left to the contractor to spend time and money on that sort of thing, which should be done in the factory.

Mr. G. C. Burnand did not think cleat wiring would be a great success in an ordinary workman's cottage. In some towns there was three-phase, four-wire distribution, and the Board of Trade had consented to allow them to work with a continuously earthed neutral. That meant that transformers between the company's mains and the wiring could be dispensed with. The Fixed Price Light Co. did not find that there was any tendency on the part of consumers to remove the lampholder and put in one of their own, though they had some 5,000 consumers. The tendency to leave lamps burning all night had also been exaggerated. The consumption worked out at about 28 units per annum per lamp sold. The charges were 4d. per 30-watt lamp, and 5d. per 50-watt, and it was a paying concern. Metal-cased wire was used.

Mr. S. W. Melsom said the Earthing Sub-Committee spoke in the Report of the rise in temperature for bare conductors of various sizes carrying twice the working current allowed by the Institution rule for the same cross-sectional area of insulated conductor. What they had taken was the fusing current. In the table relating to pure tin fuse, the working current of 33⅓ per cent. should, he thought, be 66⅔ per cent. They stated that "the function of the earth wire was to enable the fuse to blow." If the Institution was going to accept that definition of an earth wire it would be an easy matter to draft the clauses relating to earthing. He was doubtful whether earth plates or cylinders would carry the 200 or 300 amperes contemplated by that Report. He found on making tests of earthplates that the resistance between the plate and the coke was nothing, but the resistance between plate and plate was from 60 to 70 ohms. The pressure contemplated by the Wiring Rules was 300 volts, and putting the 300 volts on that there would hardly be enough current to warm up the plates. Water pipes were better, but if it was to be ensured that the earth should be a protector to the cable the Wiring Rules must include a proper system of continuous conductor running through the building and running not to earth, but to the earthed conductor. It was no good to rely on earth plates and water pipes should not be relied upon if currents of this magnitude were to be carried.

Mr. Chas. A. Baker had tried to get a system absolutely safe and reasonable in cost. It must be fireproof and foolproof. He had come to the conclusion that screwed conduit was the best solution—a skeleton screwed tubing system, running from the top of the house to the bottom. Two or three feet from the floor there should be a plug to which cooking appliances could be attached. Contractors should make an allowance when chain pull switches were used.

Earthing.*

The Sub-Committee were asked to "consider the whole question of earthing (including the time element of circuit-breakers, the heating of conductors, the current-carrying capacity of the apparatus earthed, the drop of pressure in metal sheathing and the number of earth wires required)." They first proceeded to determine experimentally the heating of earth wires, in according with Rule 34 and Rule 98 (*b*) in the Seventh Edition of the I.E.E. Wiring Rules. The temperatures arrived at were much higher than will be considered safe. Thus, a No. 14 wire reaches a temperature of nearly 900° F. from an atmospheric temperature of 60° F., and a 7/18 S.W.G. stranded conductor 1,045° F., in three minutes from the application of the current, and both are visibly red hot.

A brick wall has a considerable cooling effect, but it is not considered safe to calculate the sizes of earth wires for a given current, except on the assumption that the wires will be entirely surrounded by still air.

An earth wire should be so designed in size that, assuming the correct operation of the fuse, the temperature could never rise to that of the melting point of tinman's solder, *i.e.*, about 392° F.

The size of a conductor necessary to fulfil this condition is determined by the maximum current that may flow, and by the time during which it flows, if the interval of time is anything less than that necessary to raise the conductor to its maximum temperature at the given current.

No time limit is specified in Rule 98 (*b*) and a fuse designed for the limits allowed by the Institution Rules would therefore permit of a serious overheating of the conductors if it is correct to assume that the "maximum current permissible" refers to the working load of the cables.

Using the formula of Messrs. Melsom & Booth it is found that those conductors on which less than three times the working load is allowed might reach in from 3 to 10 hours, depending on the size, a temperature above the atmosphere of over 100° F. for rubber- insulated cables, and over 110° F. for fibre-insulated cables, and those sizes on which an overload of anything less than twice the working current is allowed a temperature of over 80° F. for rubber and 200° F. for fibre cables.

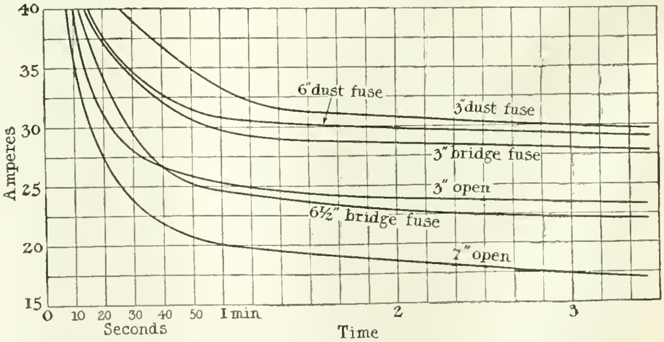

Fig. 1. Fusing Currents of a 0·064 in. pure Tin Wire up to three Minutes.

It is not advisable to raise the allowable maximum temperatures for rubber- or paper-insulated cables. It is undesirable on economic grounds to lessen the allowable working current on the conductors if it can be avoided but the allowable working current should be based on a maximum atmospheric temperature of 80° F. instead of 100° F. as at present.

There would then be a margin between the working temperature and the maximum allowable of, in the case of rubber cables 30° F., and for fibre 46° F., instead of at present only 10° F. for rubber cables and 26° F. for fibre cables.

The ideal fuse from the point of view of permitting the maximum working load on the conductors, with a given limitation of temperature rise on the cables under all circumstances of overload, would be one that interrupted the circuit with the minimum excess current over the load it would carry with stability; and it is necessary that we should have a fuse that will act within the limits of temperature stated above.

Fuse Metals.

Copper fuses as now commonly used are unsuitable for this purpose, as the margin between the safe working load and the fusing current is a wide one compared with other metals available. It seems evident, therefore, that we must use a metal having a low melting point and one that is as nearly as possible non-oxidizable at any lower temperature than its melting point. The choice appears to lie between lead, solder, and tin and pure tin wire seems most nearly to meet requirements. The melting point is low, the metal is strong and not too ductile, and it is practically free from deterioration at temperatures below the melting point.

In order to admit of the ready testing of a fuse the current at which the fuse will melt in one minute from the application of the current starting from cold should be specified rather than the present practice of specifying the current at which it will eventually melt, as such a test carried out with reasonable accuracy would require hours for its completion.

Operation of Fuses.

Figs. 1 and 2 show some characteristic curves for tin fuse wire 0·064 in. diameter with different typical mountings. Fig. 1 shows the fusing currents up to a 3-minute intervals from the application of the current, and Fig. 2 the fusing currents up to one hour and the probable maximum carrying capacity. A sufficient allowance for determining the working current is to deduct 33⅓ per cent. from the 1-minute fusing current, which will make the fusing current 50 per cent. above the working current. This gives with a tin fuse wire a sufficient margin over the working current to allow for variables, such as size, &c., for all types except dust fuses. This type of fuse can be provided for by making the working current 50 per cent. of the 1-minute current.

The environment of a fuse has a marked effect both on its ultimate carrying capacity and on the value of the current at which it will break circuit in a given time. It is therefore desirable that any new Rules should make it clear that a standard fusing current for a given size of wire cannot be stated unless both its environment and length are known. The Sub-Committee therefore recommend that the Institution Rules should specify the use of pure tin fuse wires only, and that these should be so proportioned to their type of mounting, for all sizes of fuses, that they will interrupt the current in one minute from the first application of a current 50 per cent. above the maximum working current allowable by the Rules to be carried by the smallest section of cable protected by the fuse.

The Sub-Committee also recommend that where mechanical circuit breakers are used they shall be so designed that the conductors protected by them cannot exceed the limits of temperature allowable with wire fuses, that is to say, a circuit breaker can safely operate with an increasing overload the shorter its time element; in round figures 250 per cent. if the circuit is to be opened in 10 secs. from the time of the overload and 400 per cent. if in 5 secs., but the Sub-Committee recommend that 400 per cent. should be the extreme limit of overload however much less than five seconds the time element may be.

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* Abstract of the Report of the Earthing Sub-Committee of the Wiring Rules Committee of the Institution of Electrical Engineers. The Sub-Committee consisted of Mr. G. S. Ram (Chairman) and Messrs. J. Frith, G. H. Nisbett and A. L. Taylor.

Value of Earthing Current.

Provided the path of a leakage current equal in volume to the main current does not exceed the lengths given in the last two columns, the current traversing the sheathing or conduit is bound to exceed the carrying capacity of the fuse, and the circuit will therefore be opened before any undue heating can take place. Theoretically, for each size of cable sheathing or conduit a different length can safely be worked with one earth, but as the minimum length of 150 yards for any one size at the lower voltage is well within the limits of practical requirements in all but very exceptional cases, we suggest that it be adopted as the maximum length allowable. As the wire armouring when used on rubber-covered cables has a carrying capacity in excess of that provided by lead covering if used, we suggest that the same rule should apply. The Sub-Committee are of opinion that the Rules should clearly state that tape armouring must not be used for earthing purposes.

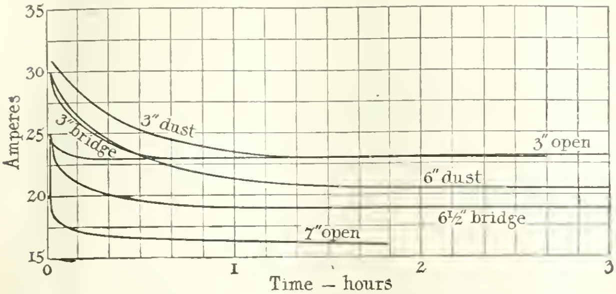


Fig. 2.—Fusing Currents of a 0·064 in. pure Tin Wire up to one hour and probable maximum Carrying Capacity.

In the case of paper cables, owing to the larger working current allowed, the earth wires need to be larger than for rubber-insulated cables, and even larger than the working conductor itself in the smaller sizes. Earth wires for both types become progressively smaller relatively to the working conductor as the size of the latter increases.

Size of Earth Wires.

Two alternative rules can be formulated One is : No earth wire shall be less than 1/14 S.W.G. Subject to this, earthing conductors for paper cables shall, for all sizes of working conductors up to and including 0·05 square inch, be equal in area to the working conductor. For sizes from 0·05 up to and including 0·15 square inch, they shall be equal to 66 per cent., and, for sizes over 0·15 square inch, equal to 50 per cent. Subject to the same limitation as to 1/14 S.W.G. being the minimum, earthing conductors for rubber-insulated cables shall, for 0·0125 and 0·022 square inch working conductors, be equal in area to 66 per cent. of the main conductor. For sizes 0·035 to 0·10 sq. in. inclusive, 50 per cent. ; for sizes 0·125 to 0·3 sq. in. inclusive, 33 per cent. ; above 0·3 sq. in., 25 per cent.

The Sub-Committee, however, think that a specified size and number of earth wires should be nàmed for each size of main conductor.

Upon the assumption that the foregoing suggestions are adopted, it is recommended that :—

1. Earthing conductors must be of the numbers and sizes set forth in the tables attached to the rules for each size of working conductor.

2. That they should be of high conductivity copper, tinned or otherwise protected against corrosion, and protected against mechanical injury.

3. That the smallest allowable size of earthing conductor should be 1/14 S.W.G., and the largest individual conductor should be 19/17 S.W.G., and that all conductors larger than 1/14 S.W.G. should be stranded.

4. When a larger section of earthing conductor than 19/17 S.W.G. is necessary, separate conductors must be used, and if earth plates or cylinders are employed, separate ones for each conductor must also be used.

5. Buried earth plates or cylinders must have an earth contact of not less than 4 sq. ft., and be surrounded on all sides by not less than 12 in. depth of finely broken coke. They should preferably be of cast iron or other durable metal and the place selected for burying them must be permanently wet or, at least, damp.

Note.—The requirement of the present rule to the effect that the coke used must be free from sulphur has been deleted. The sulphur now contained in coke does not in practice exceed 2 per cent., and it is not in such chemical form as to be readily converted into sulphuric acid.

6. Wherever an earth wire is connected to a pipe, or conduit, or cable sheath, or armouring, a substantially designed clip must be used. Sweating sockets also must be used at each end of the earth conductor for all sizes larger than 1/14 S.W.G. For armoured cables substantial clamps must be used, so designed as to grip firmly the whole of the wires of the armouring without damage to the insulation.

7. Where special earth plates are not provided extreme care must be taken to see that only such earths are used as are easily capable of carrying the maximum current which can be allowed to flow by the largest fuse used in the circuit in question. From this point of view water pipes directly in connection with the street watermains make excellent earths. Steel frameworks of buildings must not be used as earths.

In conclusion, the Sub-Committee strongly recommend that Rule 2 (*b*) providing for the need of earthing all metal other than the conductor on circuits where medium pressures are used, be extended to include low-pressure circuits also, and that it also be extended to prescribe the earthing of all metal liable to be electrically charged, such as constructional steel-work.

The Work of the Late Lord Rayleigh.

Grouping Rayleigh with Maxwell, Stokes and Kelvin, Sir J. J. Thomson remarked, in a discourse delivered at the Royal Institution last Friday, that the work of the "Physicists' Physicist," its unrivalled technique, its refinement and difficulties, and his dynamic insight into the real nature of problems, could only be appreciated by the expert. Confining himself to some matters of daily experience, Sir Joseph Thomson first referred to Rayleigh's work on the theory of resonance, in which he had allowed for the influence of the resonator-hole, which made the problem very difficult, and on audition. That sound waves coming from the left seemed more intense in the left ear than in the right had been ascribed to the shadow effect of the head. That could only be correct in cases when the sound waves were short by comparison with the distance between the ears. Rayleigh applied telephones to both ears, varied the phases in the two circuits, and demonstrated that the ear possessed the power of detecting difference of phase in addition to differences in pitch and intensity. We probably distinguished sound direction by both these means ; but it was not clear how we distinguished between sounds from the front and the back, and whether small insects could have any such power. In sensitiveness our ear, which responded to pressure differences of one hundred millionth of an atmosphere, far surpassed all measuring instruments, and the sensitiveness of the eye seemed to be of the same order. In the Whispering Gallery of St. Paul's the sound waves were concentrated near the wall (Rayleigh), whilst the aperture of the fog horn should be given the shape of a vertical slit, not a horizontal slit, to spread the sound sideways. Turning to fluid motion, capillarity and the problem of flight, Sir Joseph said that Rayleigh had proved the lift to be proportional to $\sin \theta$, and not to $\sin^2 \theta$ (where θ was the angle between the plane and the direction of motion), as had been believed, and had thus established the questioned possibility of the flight of planes. As regards the formulæ for the resistance to the motion of aeroplanes, model experiments and the principle of dynamic similarity left a small difference between theory and practice. Investigating the soaring of birds, Rayleigh had, in 1892, suggested that a bird dropping from high up where the wind was strong, into a calmer layer, would acquire energy to shoot up again, and that was now accepted. Electrical and magnetic experiments had chiefly occupied Rayleigh when professor at the Cavendish Laboratory in 1879 and 1884 ; his work on fundamental units had not been corrected by more than 1 or 2 parts in 10,000 ; the relatively high resistance of alloys Rayleigh ascribed to thermo-electric forces between the constituents. To Rayleigh's optical work—on parts of which, he mentioned, the present Lord Rayleigh was going to lecture after Easter—Sir Joseph made only one reference. It concerned the resultant of a large number of vibrations of the same period, a fundamental problem of molecular physics, popularly known as the drunkard's walk. If a drunkard walked straight for a certain distance, then stopped, and again kept straight for the same distance in another direction, and so on n times, he might or might not get far from his origin; but if there were many people in that condition they would finally find themselves concentrated within $\sqrt{n}$ times that distance from the origin. Sir Joseph added the interesting fact that, as secretary of the Royal Society, Rayleigh discovered and had published a paper by Waterston anticipating a kinetic theory of gases, which the Society had rejected 50 years previously. Sir Joseph further referred to the discovery of argon, and to the very important influence that Rayleigh had exercised as chairman of the Executive Committee of the National Physical Laboratory. Some of his own exceedingly simple apparatus were exhibited in the Royal Institution, and Sir J. J. Thomson quoted from Rayleigh's presidential address to the British Association: "Do not place too much reliance on the instrument maker."

The Work of the British Electrical and Allied Manufacturers' Association.

The annual general meeting of the British Electrical and Allied Manufacturers' Association was held on Thursday, March 18, Mr. W. O. Smith, chairman of the Council, being in the chair. In presenting the annual report the chairman paid a tribute to the work of Mr. Davenport, who had held that position during the war, and expressed the hope that he would shortly be restored to health again. Although it was not within the province of the Association to deal with labour and wages questions, it must be recognised that labour difficulties, including the recent strike of moulders, had had their effect on all industries. This, coupled with the general increase in wages, the shortage of materials, and the feeling of unrest had prevented the industry from reaping the full benefit which would have been expected from the victorious ending of a five years' war. It was to be hoped that reason would at length prevail, and that some path would be found along which employers and employed might march side by side, and so enable the country to emerge from a period of weakness to rise once more to the proud position that it had held as a leader of commerce.

Reviewing in detail the work of the Association during the year, the Chairman called attention to the work of the Electrical Research Committee, which was at present restricted owing to lack of funds. Given the necessary funds and the consequent Government grant, researches could be carried on expeditiously and much work now in contemplation could be put in hand. The council considered that collective research was not only desirable but necessary in the interests of the industry. In order to obtain the Government grant a large sum per annum for a period of five years would have to be guaranteed. The necessity for increasing their office accommodation had carried with it the necessity for increasing the maximum subscription, but this would only affect the larger firms. He was glad to say that some of the larger firms had already come forward to express their intention of paying the maximum subscription regardless of wages.

In the annual report of the Council, which was presented and adopted at the meeting, it was pointed out that the B.E.A.M.A. was strong when it entered the war, and it had emerged from it stronger than ever. It was evident, therefore, that the principles on which it had been founded were such that they remained practically undisturbed even by such amazing events as those which the world war had brought in its train. It had to be borne in mind that they were now confronted squarely with all the problems of peace, but the B.E.A.M.A. was an organisation tested by war and qualified to deal with any emergencies.

Of peace problems, none was more important than the development of export trade. Export inquiries had been secured in sufficient numbers practically to absorb the members whole productive capacity. The home demand was such as also to call upon their utmost capacity. If the export demand was not met there was a grave danger in losing the future world markets upon which when the home orders diminished everything would depend. The Council therefore recommended that the greatest efforts should be made to go vigorously into the markets abroad, even if it meant sacrificing a portion of the home market. Attention was called to the very complete organisation which existed for obtaining information from the colonies and foreign countries.

As an example of the work that had been done, it might be mentioned that the Government of India had accepted the recommendation that the British standardisation frequencies of 25 and 50 cycles per second should be adopted for all hydro-electric and other transmission schemes in that country. Proper status had been secured for H.M. Trade Commissioners abroad, and the Board of Trade had adopted a new classification of imports and exports based upon the proposals furnished to them by the Association. Attention is also called to failure of the Government to fulfil their promises to prevent restriction of foreign imports, and to the report of the Education Committee, which is referred to in our Leading Article in this issue. Work has been carried on by the Association in conjunction with the Institute of Metals on the question of the corrosion of condenser tubes, and the Association has also been represented on the International Electrotechnical Commission, on the British Engineering Standards Association, on several committees of the Institution of Electrical Engineers, and on the Electric Vehicle Committee. Gratification is expressed at the popular favour which is being found with the Standardisation Rules for electrical machinery issued by the Association and the increasing tendency of municipal engineers to regulate their contracts by the I.E.E. model conditions, or such other reasonable equivalent. Concessions have been obtained during the year from the Railway Clearing House on the question of goods rates, but attention is called to the fact that there is at present an entire lack of uniformity in the manner of charging these rates, not only by the various railway companies, but by the local goods departments of the same companies.

In order to meet the increase in rent and general increase of staff and other expenses, the Council of the Association has decided to raise the maximum subscription from the present figure of £200 to a new maximum of £500. The number of members on the register at the end of the year was 225, 19 members were admitted to membership during that period and 10 resigned; of these resignations, six were accounted for by amalgamation and re-construction.

Correspondence.

LOSSES IN TRANSFORMERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have just seen Mr. J. R. Beard's letter on the above subject in your issue of the 12th instant.

Mr. Beard makes a good point when he emphasises the fact that the copper loss, being a peak load loss, is of greater importance than the iron loss, which occurs with a load factor of 100 per cent., and his method of valuing the losses is, no doubt, scientifically accurate, although it must be borne in mind that the charge per kilowatt maximum demand will be considerably less for transformers situated at the power house than for transformers on the consumer's premises, as, in the latter case, the capital charges on the distribution system must be included.

Though it is arguable that Mr. Beard's figure of £3 per kilowatt maximum demand may be a fair one in certain cases, his figure of 0·2d. per unit is certainly too low for present-day conditions, and would not even cover the cost of coal. If we assume this to be 42s. per ton, and the coal consumption 2·5 lb. per unit, which are certainly not high figures, the cost of coal per unit works out at 0·56d. What further charges should be added to the cost of coal is a debatable question, but, however low these are kept, it will be seen that the figure of 0·5d. given as the basis of an example in my article was on the low side.

In order to avoid confusing the argument by the more complicated though more scientific calculation suggested by Mr. Beard, I kept this figure purposely low. With Mr. Beard's method of working, and a charge of 0·6d. per unit, the difference between the two cases considered in my article comes to very nearly the same figure as that given in the article.—I am, &c.,

London, March 22. Reginald O. Kapp.

ELECTRIC WINDING ENGINES AND MINE HOISTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In my article on "Rating of Winder Motors" in the current number of The Electrician I regret that a mistake was made in the lettering of Fig. 2 (d). The corrected diagram is given below:

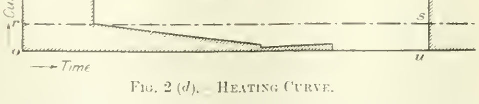


Fig. 2 (d). Heating Curve.

I also suggest that the sentence 19 lines from the top of the left-hand column of p. 341 should be altered to read: "In other words, the *rectangular* area *orsuo*, in Fig. 2 (d) is equal to the cross-hatched area."—I am, &c.,

Pinner, March 28. H. H. Broughton.

[We regret we have had to hold over some correspondence.—Ed. *E.*]

The Electrician.
FRIDAY, APRIL 2nd, 1920.
Price ONE SHILLING. By Post 1s. 1d. Ann. Sub.: U.K. 52s., Abroad 54s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

Education and Training of Electrical Engineers.

To borrow from the military vocabulary, the need of the British industry at the present time is for N.C.O.'s and men. A good deal of the present-day education seems to have for its only result the breeding of a discontent which is far from divine, leading to an ever-increasing recruitment of the ranks of the black-coated brigade and to a growing disinclination to learn a trade and work with the hands because it is not respectable, or for some equally silly reason. There is also an idea that to write in an office is more aristocratic than to work at the bench, and that the pen is the only fit weapon for a man who either wants to get on or to live an easy life, both equally desirable things to the modern youth. But this is surely too democratic an age to allow such a theory to go unexploded.

The need for men is particularly great in the electrical industry at the present time. We want more workers, and not only must they be workers, but they must be skilled workers, for there can be few industries which require so large a proportion of its followers of all grades to be highly trained. Our youths, therefore, would do well to consider their future careers from this point of view, especially as they may rest assured that in the electrical industry at any rate there is no bar to promotion to the highest ranks, except lack of knowledge, using the term in the widest sense. Now is an opportune time to enter such a profession as ours, for there is no doubt that the use of electricity for all purposes will increasingly develop for some years to come.

Our Present Responsibilities.

The recruitment of youths into the industry imposes certain responsibilities on those who are already working in that field. We are, therefore, glad to see that this question of education has been receiving the attention of a committee of the British Electrical and Allied Manufacturers' Association, under the chairmanship of Mr. A. P. M. Fleming. This committee, whose report has recently been published, was appointed "to consider the whole subject of technical education in the electrical and allied industries, and to suggest a uniform system." These terms of reference, it will be agreed, are sufficiently wide, so wide as to make the temptation to stray off into adjacent paths almost too strong to be resisted. But the committee have done their work in a way which compels admiration and almost disarms criticism. Their report is worthy of close study by all those who are, and even more by all those who ought to be, interested in the subject. We hope that it will not be pigeonholed, but that the recommendations made will be adopted without undue delay.

How Electrical Workers Should be Trained.

The report lays down a complete scheme for the education and training of all grades of workers with the exception of unskilled workers, adult workers and women. The word "education" is taken to apply to mental training, and the word "training" to manual education, if we may so explain the nomenclature adopted by the committee. For this purpose apprentices are divided into four classes: Trade apprentices, engineering apprentices, student apprentices, and research apprentices. The first of these classes would include boys from 14 to 16 years of age, with a primary or lower secondary education, who would undergo a five years training from the age of 16 to fit them for jobs as skilled workmen, charge hands and foremen. The second class would include boys with education up to matriculation standard, who would be given a four or five years training to fit them for positions in the drawing office, test room or on the engineering, commercial or erecting staffs. The third class would be for men with a university education, who, after three years training in works, would be suitable for senior staff positions. From this class would be chosen research apprentices to undergo a post-graduate research course. It will be noted that these last two classes include what are now often called pupils. But we are glad to see that the premium system is condemned lock, stock and barrel, and that the very sensible suggestion is made that remuneration at a rate to ensure maintenance must be given to all classes of apprentice. This is most important, for while no commercial concern can be expected to turn itself into a charitable institution, no boy, or man, for that matter, can work his best if he is not properly fed and housed.

Improvement in Primary Education Necessary.

We have indicated in a general way the course of study which it is proposed the youth anxious to become an electrical engineer should follow. Full details are given in the report in a way which shows the meticulous care that has been expended on its preparation and in the consideration of its multitudinous details. One point to which we are glad to see special attention is called, is the need for considerable improvement in primary education. The old parable of the seed which was sown in stony ground is as true when applied to British education as to other branches of life. It is no good for engineering firms and technical institutions to spend time and money on educational schemes if the mind of the pupil is not properly prepared from the earliest days. Our present primary education, if not a scandal, is at any rate quite unworthy of the mighty British Empire. In this field more than in any other should the greatest attention be paid to instruction in fundamentals. In too many cases the door by which the boy leaves the primary school is the same as the one by which he enters, and it is not until he leaves school that his real education begins. More attention must be given to saving these wasted years.

The success of such a scheme of education and training as suggested by Mr. Fleming's committee must depend not only on the care with which it is devised, but upon the mentality of the person appointed to carry it out—on the apprentice-supervisor, as he is conveniently called. It is almost impossible to think of any good quality which this man must not have and sympathy he must certainly have in superabundance. To deal with youths who have ceased to be boys, and are not yet men, who are sensitive and at the same time cocksure, who are surprisingly well-informed and appallingly ignorant, is not an easy task. It is not going to be performed by some recent product of the university or even of the technical colleges. What is required is a man who has not only seen but known life, and can perceive both its good and its evil.

A London Traffic Board.

The Advisory Committee on London Traffic, over which Mr. Kennedy Jones, M.P., presided, recommends the setting up of a London Traffic Authority, which must be a permanent statutory body responsible to the Minister of Transport. The grave condition of London traffic and the acute problems arising from it render it essential (they say) that the authority should inspire confidence that remedies will be applied effectively and expeditiously. The committee suggest that three experienced members be appointed, and salaries recommended are £4,000 per annum for the chairman and £3,000 each for the other two commissioners. The powers of the Authority would be delegated to it under Act of Parliament by the Minister of Transport, who could veto any scheme, plan or recommendation of the authority, but the veto of local authorities should be abolished in the Greater London area. The area of the Authority would be the existing Metropolitan and City Police boundaries.

The duties and powers of the authority would include the preliminary examination of all Bills affecting the means of locomotion and transport in the London area, the making of surveys and preparations of traffic schemes, the study of all town planning and housing schemes, the co-ordination of all passenger transport agencies, the selection and prescription of routes, the fixing of building or frontage lines on roads, scientific research work, the right to initiate or oppose traffic legislation, arbitration between authorities in regard to apportionment of the cost of improvement schemes and the approval of designs for road vehicles for the transport of passengers.

New Tubes and Tramways Needed.

The need for the creation of a London Traffic Authority is made the more urgent by the serious financial condition of the traffic undertakings. The public demands everywhere have vastly outstripped transport facilities. London requires new tube railways, in all cases linking up with main line railways; new tramway extensions, which will make for greater carrying capacity; a more scientific development of omnibus traffic; and, above all, a just and true perception of the proper functions of each form of transit in order that wasteful competition may be avoided, and each used to its highest efficiency. The committee, who do not suggest that the new authority should have power to fix or vary fares, detail the steps taken to improve and co-ordinate traffic facilities, and suggest that the institution of a left-hand rule for the footpath would be preferable to the existing custom.

Legal Intelligence.

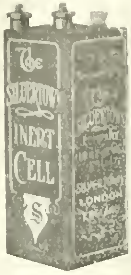
Condensing Apparatus Patents.

On the 25th ult. Mr. Justice Eve delivered his reserved judgment in the action brought by the Contraflo Condenser and Kinetic Air Pump Company, against Messrs. Hick, Hargreaves & Company, Ltd., for alleged infringement of Patent No. 23,140 of 1907, granted to Mr. D. B. Morison. The patent, which relates to "improvements in or relating to apparatus for withdrawing condensed steam water, air and vapour from steam condensers," was amended in 1915. Plaintiffs claimed that the object of the patented invention was to remedy certain alleged defects in the condensing apparatus patented by Sir Charles Parsons in 1902, and which they said chiefly lay in the waste of the heat of the steam used in Parsons steam jet. Defendants contended (amongst other things) that the specification of the Morison patent did not clearly define the monopoly purported to be protected and was incapable of bearing the meaning which plaintiffs sought to put upon it.

In the course of his judgment Mr. Justice Eve said that it had to be borne in mind that the language he was called upon to construe was the language of a man (the patentee) thoroughly conversant with the state of the art existing when he formed his specification, fully cognisant of and (if the construction claimed by plaintiffs was the right one) quite alive to the defects in the existing apparatus, which the invention was designed to remedy, and competent to describe in plain and intelligible language the nature of that invention and the manner in which it was intended to effect the remedy. In his opinion the essence of the invention had nothing to do with the conservation of heat, which he did not think had ever presented itself to the mind of the individual who framed the specification. Even if he could have adopted plaintiff's construction of the specification, he thought it would have been difficult to detect any substantial feature in the invention not already included in the Parsons patent. Moreover if the only possible feature of difference from the Parsons patent which he could detect had been held sufficient to support the Morison patent it would not have availed plaintiffs, inasmuch as it was not reproduced in defendants' alleged infringing apparatus. The action was therefore dismissed with costs.

At the Bakers' Exhibition, Glasgow, there is a good display of electrical machinery specially suitable for bakeries. The exhibitors include Messrs. Malcolm & Allan, J. G. Jackson, Ltd., Belhaven, Ltd., Hobart Manufacturing Company, Read's Bakers' Machinery, T. Melvin & Sons and David Thomson, Ltd., Edinburgh.

Silvertown Inert Cells.



In a leaflet, which is reprinted from the Battery catalogue of the India Rubber, Gutta Percha and Telegraph Works Company some particulars are given of the Silvertown inert cells. Possessing all the advantages of the dry cell it is claimed that these cells will keep indefinitely in stock without deterioration, and therefore they are particularly suitable for hot, humid climates. They are supplied perfectly inert, and no action takes place until water is added. The water is then absorbed and the cells become practically dry cells. In order to render a cell active the cork is removed and pure water poured in until it reaches the top of the tube. After an interval of ten minutes more water is poured in to replace that absorbed. The cell is then usually left for eight or ten hours in an upright position, after which any free liquid is shaken out and the cork replaced. The leaflet gives particulars of the E.M.F. internal resistance, size and approximate weight of the various types of inert cells made by the company.

New Glasgow Electrical Engineer.

At their meeting on Thursday, March 25, the Glasgow Corporation confirmed the appointment of Mr. R. B. Mitchell as Chief Engineer and Manager of the Glasgow Corporation Electricity Department.

Mr. Mitchell is a native of Glasgow, and was educated in that city at Allen Glen's School, Anderson's College and the Royal Technical College. He served a mechanical apprenticeship with a firm of marine engineers, and after working for a short time as a journeyman took up electrical work. After having had charge of a small plant at Edinburgh for two years he entered the service of the Glasgow Corporation Electricity Department some 22 years ago, and was promoted through the various grades till he became Resident Engineer for Port Dundas power station, later Mains Superintendent, and three years ago was made Deputy Chief Engineer. He has been closely identified with the recent development of electricity supply in the Glasgow area, which finds its main embodiment in the new Dalmarnock power station, which when completed will be one of the largest power stations in the kingdom. Mr. Mitchell is an active member of the committee of the Scottish Territorial Centre of the Institution of Electrical Engineers. Mr. Mitchell is still on the right side of 50 years of age, and he enters upon his new duties with the goodwill of a wide circle of friends in the electrical profession and industry. We publish a recent photograph of Mr. Mitchell, by Lafayette, of Glasgow.

Commercial Topics.

Ferrous Material Sales.

The Disposal Board, Ministry of Munitions, announces that large contracts for the sale of ferrous material having been entered into, it is necessary to suspend further sales for a short period in order to effect clearance from stores and depots involved. The Ferrous Material Section of the Board (Block C, Earl's Court Exhibition Grounds, S.W.5), will, therefore, suspend sales from April 6, till May 3.

* * * *

Electrical Plant for Fiji.

By a recent Ordinance, the Municipal Council for Suva has been authorised to construct and operate electric supply works and to generate and supply electricity within a distance of three miles beyond the municipal boundaries of the town. By a clause of the Ordinance, all plant, machinery, and all materials, apparatus and equipment imported into the colony for the original construction of the works shall be admitted duty free.

* * * *

Payment by Results.

We are pleased to see that the principle of payment by results is being accepted by an increasing number of workers. At the recent conference of the National Federation of General Workers, which has a membership of about 1½ million workers (including a number of men employed in engineering workshops), the principle of "payment by results" was adopted for the engineering and shipbuilding industries. The engineering Unions are taking a ballot on the question this month, but the result will not be known until the end of April.

If the scheme prepared by representatives of the employers and workers, which appears to preclude the possibility of unfair advantage being taken of the latter were generally adopted and loyally carried out by both parties, it would remove many of the difficulties of the engineering and allied industries and it would greatly assist in increasing production.

* * * *

Decimal Coinage Report.

The Royal Commission on Decimal Coinage, which was appointed in 1918 to consider Lord Southwark's Bill for placing the coinage of the United Kingdom on a decimal basis, have issued their report, which is adverse to the proposals outlined in the Bill on the ground that "the existing system is admirably suited to the needs of everyday life," and that decimalisation would present great difficulties without compensating advantages. Particulars of Lord Southwark's and other schemes of decimal coinage have been given in The Electrician. The majority report is signed by 13 members and among their conclusions are :—

1. In any scheme of decimalisation, the pound sterling should be retained.
2. The £-mil scheme of Lord Southwark is the only strongly supported scheme complying with this condition.
3. The advantages gained by this system as regards keeping accounts are in no way commensurate with the loss of convenience of the existing system for other purposes.
4. Grave difficulties will be encountered by any alteration of the penny.

There are two minority reports. The report of Lord Southwark, Mr. H. Cox, Mr. McKenna and Mr. Vyle considers that, while there are grave difficulties in the way of introducing decimal coinage, the advantage to be gained by the proposed reform justify the effort required to overcome the obstacles in the way. The second (by Lord Leverhulme, Mr. G. Hayhurst and Capt. A. Smith) rejects any scheme accepting the pound sterling basis, and recommends the adoption of the half-penny as the basis, 500 halfpennies to make the unit, which would be known as a Royal.

* * * *

Increased Production.

There is general agreement upon the urgent need of increased output, for upon this depends the lowering of prices and the allaying of industrial unrest. Indeed the future well-being of the Empire and its capacity to meet the interest on the huge National Debt and its other liabilities are closely bound up with the solution of the problem. Although there has been much discussion upon this important subject no definite scheme has been put forward as to the best method of obtaining the desired increase in production.

The Government have now set up a committee to inquire into and report on the whole matter. The committee will consist of an independent chairman and a "permanent" nucleus composed of two employers, two Labour representatives, and two Government representatives, together with additional representatives appointed, two by the employers and two by the workpeople, to represent any particular trade which may be under consideration by the Committee. The personnel of the Committee is as follows :-

Sir Stephenson Kent, K.C.B. ; Mr. I. Haig Mitchell ; Lieut.-Col. D. Paul, C.M.G. ; Mr. A. A. Purcell ; Sir Thomas Robinson, M.P. ; Sir Allan M. Smith, K.B.E., M.P. ; and Mr. G. H. Stuart-Bunning, J.P., O.B.E. The secretary is Mr. W. H. Reynolds, M.B.E., Ministry of Labour, Montagu House, Whitehall, S.W. 1.

The terms of reference are ; "To consider and advise as to the best means of securing the greatest possible production consistent with the permanent well-being of industry and of the employers and the workpeople engaged therein." The first trade to which the Committee will give consideration is the building trade.

Electricity Supply.

Bolton Electricity Committee is to carry out important extensions at the Back-o'-th'-Bank power station at a cost of £140,000.

Cupar (Fife) Council will not establish a municipal station, but the Fife Electric Power Company is to be asked to extend its mains to the town.

Walsall Corporation has increased the salary of the borough electrical engineer (Mr. H. A. Howie) to £800, rising by annual increments of £25 to £900.

Hastings Corporation has withdrawn its opposition to the Bill of the Hastings Tramways Company for authority to employ the overhead system on the sea front.

The Blackburn Guardians desire to engage the borough electrical engineer (Mr. P. P. Wheelwright) as consulting engineer for the electric lighting scheme at the local institution.

Blackburn and Preston Corporations have asked the Ministry of Transport to sanction the laying of an electric supply main to link up the suplpy undertakings of both towns

The Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board has applied to the Electricity Commissioners for authority to form a Joint Electricity Authority for the undertakings of the Board and of Ashton Corporation.

The Electricity Commissioners are to be asked to authorise the formation of a Joint Electricity Authority for the North West Midlands, which will include Wolverhampton and Walsall on the south, Crewe, Nantwich, Macclesfield and Leek on the north.

At a meeting last week of representatives of the Devon County Council and the Corporations of Exeter, Plymouth, Torquay and Barnstaple it was resolved to form a Joint Electricity Authority under the Electricity (Supply) Act, and arrangements are being made to send a deputation to wait upon the Electricity Commissioners.

Messrs. Howard & Bullough, having asked for a further supply of current to their Charter-street works, Accrington Electricity Committee has agreed upon a basis of charging for the additional supply. The cost of the necessary high-tension cable and switchgear will be about £2,000.

At the annual meeting of the Barnard Castle Gas Company last week it was stated that the directors were considering the question of an installation of electric lighting. The question will be investigated with a view to the adoption of electricity for public and private lighting and the report on the subject will be submitted to the shareholders in six months time.

The Lancashire Electric Power Company has power to supply electricity in Chorley under a Provisional Order of 1914, but the company's mains are still 8 miles away and a supply from any other existing authority does not appear practicable. It is therefore proposed to discuss the matter with the Electricity Commissioners with a view to formulating a scheme.

Application has been made by the Hammersmith (London) Borough Council to the Electricity Commissioners for sanction to borrow £174,000 for two 8,000 to 10,000 kw. turbo-alternators, three boilers, &c., and £21,693 for mains extensions. Subject to the sanction being obtained, application has been made to the London County Council for the advance on loan of the sums referred to, but in the event of the London County Council being unable to advance the money the Finance Committee has been authorised to take steps to obtain the loans elsewhere.

In future intending electricity consumers at Stoke-on-Trent must guarantee a return of 20 per cent. per annum for two years on the capital cost of mains extension.

From the June quarter the charge for power supply, heating, cooking and apparatus used in conjunction therewith, will be increased by a further 25 per cent. except where the supply is three-phase transformed on the consumer's premises. In the latter case the rate will be £9 per k.w. of the maximum demanded supply per annum, plus 0·8d. per unit, with coal at 30s. per ton delivered, plus 0·03d. per unit increase for each shilling per ton above this price.

In moving the adoption of the minutes of the Electricity Committee at last week's meeting of Derby Corporation, Ald. Wilkins referred to the estimated capital expenditure of £120,000. The demand for electricity was increasing enormously, and they had to place orders for machinery two years ahead. When the extensions were carried out Derby would possess an electricity supply as good as Nottingham or Leicester. It was a race between towns as to which could best attract manufacturers within their borders, and cheap and plentiful electricity was often a determining factor.

Dundee Electricity Committee has adopted the proposal of the city electrical engineer (Mr. H. Richardson) to charge for electric current according to the living room space occupied. The convener (Mr. Hynd) said there was no likelihood of being able to devise a method of charging which would please everybody, but the fairest and most beneficial method of charging was that proposed. The term "living-room" includes all rooms with the exception of bathrooms, sculleries and outhouses. The "guarantee system," though satisfactory so far as most consumers were concerned, had given rise to disputes which could not occur under the new system. The proposed tariff is 2s. per 100 sq. ft. per quarter.

Electric Traction.

The receipts of Blackburn Corporation tramways for the past financial year amount to £116,965, an increase of £25,221 over 1919.

Haslingden Council has been authorised to increase all tram fares by 50 per cent.

As Torquay Corporation has agreed upon a price to be paid by the Torquay Tramways Company for traction current the proceedings for the revocation of the existing contract with the company have been abandoned.

The Leeds Tramways Committee recommend the City Council to raise the fares to the full statutory limit of one penny per mile. The last increase raised the fares 50 per cent., and the present proposal involves a further increase of 50 per cent., making all fares double what they were before the war

The London County Council recently sanctioned a loan of £7,300 to the Hackney Borough Council for the purchase of electric vehicles for collecting house refuse. Of this sum, £1,882 is for building work and electrical plant, &c., and is to be repaid within 10 years, and £5,418 for vehicles within five years.

There is a dispute between Hull Tramways Committee and their employees as to working hours. The men demand a continuous eight-hour shift without a break, in place of the present nine hours, with an hour off for meals; their proposal being that they should take any food they require while on the car. A continuous shift of eight hours is contrary to the principle laid down by the men's Executive, and the Committee have decided to put the new time-table (a nine-hours shift, with one hour's break) into operation for two months. In the meantime the men can submit a time-table for eight and a half hours shift, with half an hour's break for a meal.

Though the tramway workers have threatened to cease work on Saturday unless their demand for an increase of 10s. a week is conceded, we believe there will be no Tramway Strike, for negotiations are still being carried on in a friendly spirit. As we go to press we learn that the employers have made a fresh offer of 5s. 6d. a week, which will probably be accepted and the strike notices will be withdrawn. Sir Eric Geddes has introduced a Bill to enable tramway undertakings to increase their fares and thus enable them to meet the increased cost of working

In the House of Commons on the 25th ult., the London Electric Railway Companies (Fares, &c.) Bill was read a second time, but it was agreed "to instruct the Committee to which the Bill may be committed, after inquiry into the financial position of the various companies concerned to amend the Bill as follows: (*a*) So as to provide that the maximum powers of charge in excess of the fares which the companies are now authorised to charge shall not be more than are required to provide from time to time for working expenses, efficiently maintaining and renewing the undertakings, and a reasonable return on capital; (*b*) that workmen's return fares between any two stations shall not exceed the single ordinary fare for a journey between those stations, with a minimum fare of threepence."

A similar instruction has been given in the case of the London United Tramways, the Metropolitan Electric and the South Metropolitan Tramways Bills.

The Highways Committee of the London County Council propose to make an experiment with railless trolley cars on the Eltham route. It is proposed to run two cars to see how they interlace with the existing tramway service. The consent of the Chief Commissioner of Police will be applied for in order to carry out the experiment, which is being made owing to the high cost of tramway construction.

The Special Committee recently appointed to investigate the general conditions under which the tramways are being operated reported to the Council on Tuesday that the question of applying the new fares to adults only would create a difficult situation if the old stage points were retained for children. At present children under 14 travel at half-price, and no further alteration should be made. The Committee also reported against re-introducing transfer tickets, return tickets and intermediate ½d. fares, which would involve an annual loss in revenue of £576,000. The Committee also recommended the introduction of cheap fares during certain slack times of the day.

The Highways Committee recommended that certain sections of the tramway track should be treated with a hardening process, which is estimated to prolong the life of the rails by about 3¼ years. The ultimate saving, after allowing for cost of treatment, would be £625 per mile of single track, and the disturbance of traffic would be correspondingly less.

Personal and Appointments.

Mr. A. A. Dee has been appointed assistant lecturer of physics at the University, Birmingham.

We are officially informed by the Ministry of Transport that Sir Harry E. Haward, Comptroller of the London County Council, has been appointed a Commissioner under the Electricity (Supply) Act.

The London County Council have promoted Mr. C. D. Johnson, the deputy comptroller, to the position of Comptroller vacated by Sir H. Howard, at £1,600 a year, rising by annual increments of £100 to £2,000 a year.

We learn that Mr Arnold B. Gridley retired from the Government service on the 31st ult., after holding the position of Director of electric power supply and electrical adviser to the Ministry of Munitions during and subsequent to the war. After a lengthy holiday Mr. Gridley hopes to resume private business.

Imperial and Foreign Notes.

Bathurst (N.S.W.) is considering the question of lighting the town electrically.

Doncaster (Vic.) Shire Council proposes to extend the electric light system to Templestowe, at a cost of £2,950.

Ripon (Victoria) Shire Council recently decided to obtain a report upon the subject of electricity supply for Beaufort.

Colac (Victoria) Shire Council has decided to adopt a scheme of electricity supply works for the town, at a cost of £11,000.

It is proposed to increase the plant capacity of the Sydney municipal power house at Pyrmont from 29,000 kw. to 50,000 kw.

The Uruguayan Post Office authorities recently decided to invite tenders for the construction of a new national system of telephones for the city and department of Montevideo.

The Compagnie des Cables Sud-Americains has applied to the Argentine Ministry of Industries for authority to establish and work a subfluvial and terrestrial telegraph service between Montevideo and Buenos Aires and a submarine cable between Montevideo and Rio de Janeiro.

We have received from Verlag fur Fachliteratur, of Vienna, two maps, one showing the privately owned electrical undertakings of the countries which were formerly part of the Austrian Empire, including Austria, the Czecho-Slovak Republic, Jugo-Slovakia, Galicia and the Austro-Italian and the Austro-Roumanian districts. The other shows the public electrical undertakings and gas works in the same countries. In both cases the undertakings are divided into three sections, depending on whether steam engines, gas engines or water power is employed and a further distinction is made in the sizes of the stations, depending on whether they are less than 100 kw., between 100 and 1,000 kw., between 1,000 and 5,000 kw., between 5,000 and 10,000 kw., or over 10,000 kw. The maps are fairly clear, but the arrangement of using fairly large circles and triangles as distinguishing marks is not a good one, especially in the industrial districts where there are likely to be a number of stations. Each map is published at the price of 15s.

Catalogues, Price Lists, &c.

Messrs. Hollings & Guest, Ltd., Thimble Mill-lane, Birmingham, have recently issued three sections of their illustrated catalogues, and copies will be sent to anyone interested. List A. 108 shows the firm's new design in gas stoves for enamelling, lacquering, &c.; list A. 106 shows scrap metal bundling presses; and list A. 107 shows their new design of hand baling press for waste paper, &c.

Electrical contractors and wiremen engaged on wiring work will be glad to learn that the General Electric Company, Ltd., 67, Queen Victoria-street, E.C.4, has prepared and issued a cardboard folder containing Comparison Tables of the old and new standards for electric wires and cables, with other useful statistics. Trade houses who require them can obtain copies for the use of their wiremen.

The Engineering & Lighting Equipment Company, Ltd., of St. Albans, has issued its new catalogue of Fittings for Half-watt and Large Metal Filament Lamps. A variety of fittings suitable for works, shop and street lighting is described and illustrated, and in almost every case the fittings are provided with a massive pair of c.i. globe rings, which are hinged at one end and held up by a single swivel and fly nut, thus dispensing with the usual chains. There are some illustrations of fittings with hexagonal lanterns, the economy of which from the replacement point of view is considerable, while there is also an illustrated description of the company's "anti-break" anti-vibration discs, which prevent (it is claimed) the breakage of the most fragile half-watt lamps under the most severe conditions, and thus enable them to be used for engine-room deck lighting, &c. For the latter purpose the Tilbury fitting, which is also illustrated, has been specially designed.

Business Items, &c.

The London office telephone of Messrs. Percy Huddleston & Company has been changed to Clerkenwell 1094.

The B.K.B. electric Motors, Ltd., have returned to their original offices at Finsbury Court, Finsbury Pavement, London, E.C.2. Telephone: London Wall 5630 1; telegrams: Driving Wheel London.

Bernard L. Myer and Wm. Fraser (trading as the Electric and Engineering Specialities Company), 79, Great George-street, Liverpool, have dissolved partnership. Debts by Mr. J. E. A. Killip, 21, Tempest Hey, Liverpool.

The partnership between Archd. S. Tong and Percy Nutter (trading as Tong, Nutter & Sons), electrical engineers, &c., 41, The Side, Newcastle-on-Tyne, has been dissolved. Debts by Mr. Nutter, by whom the business will be carried on at the old address and under the old title.

Mr. F. Peake Sexton, A.R.C.S., A.M.I.E.E., late chief technical assistant to Mr. S. G. Brown, has opened offices at 39, Parliament-street, Westminster, S.W.1, where he will practice as a consultant with special reference to gyroscopic compasses, &c., and illumination.

The Engineering and Lighting Equipment Company, Ltd., have taken over the Sphere Works, St. Albans, from the Engineering and Arc Lamps, Ltd., and have purchased their business, together with stocks, patents, &c. The entire staff is being retained, and the new Company will continue to carry on the same business as formerly, with the same manufacturers and the addition of some new articles.

Miscellaneous.

A licence has been issued by the Board of Trade to the British Refractories Research Association, whose scheme of research has been approved by the Department of Scientific and Industrial Research.

Subject to the approval of the National Council, the District Industrial Council of the Electricity Supply Industry for the West Midlands Area recommend that the Engineering and Foundry Trades Award No. 180 be applied to all manual workers in electricity undertakings. Future applications for alterations in wages, &c., in the industry must be dealt with by the National Industrial Council.

The Council of the Physical Society of London have under consideration a proposal to change the dates of the meetings from the second and fourth to the first and third Fridays in the month at 5 p.m.; or, alternatively, to hold these meetings at 5 p.m. and 8 p.m. on alternate Fridays. Fellows are requested to communicate their views on these proposals to the secretary, Mr. F. E. Smith, O.B.E., F.R.S., National Physical Laboratory, Teddington, Middlesex.

The question of the payment of an Additional Bonus to the Technical Staffs of Electricity Undertakings has been under consideration by the National Joint Board of Employers and Members of Staffs for the Electricity Supply Industry, and, in view of the advances made to workmen in the industry since the date of the award made in February, 1919, due to increased cost of living, it is recommended that a further sum of £30 be paid to members of the technical staffs as an additional war bonus on account of increased cost of living, such payment to be made as from Jan. 1, 1920. Many municipal undertakings, including Hammersmith and Stepney, have already adopted the recommendation.

On the invitation of the Mayor (Mr. Geo. Isaacs) a meeting was convened in Southwark Town Hall on March 25, for the purpose of considering the aims and objects of the Industrial League and Council, and, if the same were approved, of inaugurating a branch of the League in the Borough. Special representatives attended from the League in order to place the claims of the organisation before the meeting. Mr. G. S. Francis explained the aims and objects of the League and Council, and his remarks were followed by a long address on the subject by Mr. Robert Young, M.P. Following remarks by Mr. F. Elliott and a number of Trade Union delegates, a resolution to form a branch of the League and Council was carried unanimously and a provisional committee was appointed.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during February, 1920, and (*b*) the aggregate figures from Jan. 1 to Feb. 29, with increase or decrease compared with corresponding periods of 1919:—

Electrical machinery, (*a*) £89,320 (increase £47,795), (*b*) £198,321 (increase £135,733); telegraph and telephone cables other than submarine, (*a*) £276 (decrease £5,182), (*b*) £1,450 (decrease £5,865); telegraph and telephone apparatus, (*a*) £17,206 (increase £3,336), (*b*) £25,605 (increase £836); other electrical wires and cables, rubber insulated, (*a*) £965 (increase £954), (*b*) £2,879 (increase £2,868); with other insulations, (*a*) £10,858 (increase £7,289), (*b*) £12,744 (increase £8,549), carbons (*a*) £16,316 (increase £9,667), (*b*) £27,921 (increase £23,326); glow lamps, (*a*) £1,054 (decrease £19,712), (*b*) £5,171 (decrease £37,962); arc lamps and electric searchlights, (*a*) £120 (increase £120), (*b*) £240 (increase £240); parts of arc lamps and searchlights (other than carbons), (*a*) £1,521 (decrease £5,418), (*b*) £4,019 (decrease £13,834); batteries, (*a*) £4,010 (increase £1,531), (*b*) £5,554 (decrease £1,614); meters and measuring instruments, (*a*) £6,026 (increase £2,663), (*b*) £10,077 (increase £4,103); switchboards, (*a*) nil, (*b*) £956 (increase £742); electrical goods and apparatus unenumerated, (*a*) £45,354 (decrease £34,401), (*b*) £79,959 (decrease £15,902). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £98,706 (decrease £38,153), (*b*) £176,575 (decrease £36,513).

Exports.—The exports of electrical machinery, material, &c., (*a*) during February, 1920, and (*b*) from Jan. 1 to Feb. 29, with increase or decrease compared with corresponding periods of 1919, were as follows:

Electrical machinery, (*a*) £132,726 (increase £46,341), (*b*) £306,652 (increase £116,402); including railway and tramway motors, (*a*) £2,900 (decrease £4,810), (*b*) £5,811 (decrease £11,398); other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £66,236 (increase £19,925), (*b*) £174,423 (increase £81,089); other electrical machinery, (*a*) £63,590 (increase £31,226), (*b*) £126,418 (increase £46,711); telegraph and telephone cables, submarine, (*a*) £39,814 (increase £30,196); (*b*) £121,137 (increase £98,988); other than submarine, (*a*) £93,700 (increase £57,380), (*b*) £170,535 (increase £107,409); telegraph and telephone apparatus, (*a*) £89,176 (increase £69,784, (*b*) £187,932 (increase £144,788); other electrical wires and cables, rubber insulated, (*a*) £100,130 (increase £72,741, (*b*) £212,704 (increase £165,993); with other insulation, (*a*) £124,921 (increase £104,085), (*b*) £262,453 (increase £242,181); carbons, (*a*) £11,337 (increase £10,850), (*b*) £13,659 (increase £12,983); glow lamps, (*a*) £11,570 (increase £3,073), (*b*) £21,566 (increase £4,423); arc lamps and searchlights, (*a*) £1,463 (increase £1,384), (*b*) £1,895 (decrease £839); parts of arc lamps and searchlights (other than carbons), (*a*) £627 (decrease £1,403), (*b*) £922 (decrease £8,808); batteries, (*a*) £26,331 (decrease £4,999), (*b*) £62,160 (decrease £22,237); meters and measuring instruments, (*a*) £19,073 (increase £8,575), (*b*) £39,730 (increase £11,614); switchboards, (*a*) £4,129 (decrease £128), (*b*) £16,176 (increase £9,138); electrical goods and apparatus unenumerated, (*a*) £104,476 (increase £37,526), (*b*) £208,772 (increase £51,382). Total of electrical goods and apparatus, other than machinery and uninsulated wire, (*a*) £629,247 increase £388,974), (*b*) £1,319,641 (increase £793,023).

Tenders Invited and Accepted.

Leith Corporation want tenders by April 13 for one year's supply of overhead electrical and car fittings, insulated wire, &c. Schedules, &c. from the Burgh Surveyor.

Bedwelty Urban Council require tenders by April 12 for electric light wiring and fittings at Pengam and Aberbargoed. Specifications from the Clerk, High-street, Bargoed, or Mr. R. H. Fletcher, Cardiff.

Cardiff Corporation invite tenders for the supply and erection of a 5,000 kw. turbo-alternator and surface condensing plant. Specifications and forms of tender from the Electrical Engineer, The Hayes, Cardiff, and tenders to the Town Clerk by April 29.

Sunderland Corporation invite tenders for two water-tube boilers, with integral superheaters, mechanical stokers, vertical c.i. tube economisers, steel plate chimneys, &c.; also one 1,000 kw. rotary converter. Specifications from the general manager, Mr. A. S. Blackman, and tenders to the Town Clerk by April 28.

Canterbury Corporation invite tenders for one 1,000 kw. three-phase turbo-alternator and surface condenser two rotary converters and a superheater. Specifications from the consulting engineers, Messrs. May & Hawes, 36, Victoria-street, London, S.W.1, and tenders to the Town Clerk by 4 p.m., April 19.

Tenders are invited up to April 14 for supply and delivery to the Postmaster-General's Department, State of Western Australia of telephone and telegraph instruments, parts, &c. (as per schedule 671); and up to May 5 for the supply and delivery of insulators, bolts, brackets, &c., to the Postmaster-General's Department of the same State (as per schedule 673). Specifications from the Commonwealth Offices, Room 406, Australia House, Strand, London, W.C. 2.

The Agent-General for Western Australia invites tenders for one 7,500 kw. turbo-alternator and condensing plant for the Perth power station. Specifications and tender forms from the consulting engineers (Messrs. Merz & McLellan), 32, Victoria-street, London, S.W.1, and tender forms may also be obtained from the Agent-General, to whom tenders are to be addressed at Savoy House, Strand, London, W.C.2, by noon May 14.

Hammersmith Borough Council have received tenders from four firms for the supply of electric vehicles of 3½ tons capacity for house refuse work. The inclusive figure of the Edison Accumulator Company was £1,687 per vehicle; Messrs. Mossay & Company quoted £1,556, the Electromobile (Leeds), Ltd., £1,430, and the General Vehicle Company £1,580. The Cartage Committee recommends the acceptance of the tender of Messrs. Mossay & Company for the supply and delivery of six "Orwell" electric vehicles complete at £1,556 each, and that the Borough Engineer and Surveyor be authorised to prepare a scheme for the provision of garage accommodation, &c., at an estimated cost of £1,500.

Bankruptcies and Liquidations.

At meetings at 4, Central Bank-chambers, Leeds, on March 5 and 22 respectively, a resolution was passed and confirmed to wind up the Electric Train Lighting Syndicate, Ltd., voluntarily.

An application for the discharge of Fredk. Mitchell (carrying on business with John Mitchell as Fred. Mitchell & Company), electrical engineer, 97, Stockport-road, Ardwick, Manchester, and 58, Ashton Old-road, Openshaw, Manchester, will be heard on April 27 at the Court House, Quay-street, Manchester.

A meeting of creditors of Edward Wingfield Fuller Heath (trading as Heath Wingfield & Company), electrical engineer, 6, Hans-road, Brompton-road, London, S.W., was held at the offices of Messrs. Cortield & Cripwell, Balfour House, London, E.C., on Friday last. The trustee (Mr. Osborne) read a list of some of the principal creditors, including Hindley & Son, £921; Commercial Electrical Accessories, £210; Bliss & Company, £148; Crompton & Company, £679; Edison & Swan Company, £170 13s. 1d.; General Electric Company, £142; International Electric Company, £486; International Novelties, £163 8s. 6d.; and Rushton & Hornsby, £155 5s. There was also a cash creditor (J. T. Lane) for £2,355, less £707 10s. received in connection with a bank debt, for which sum the lender had a cover. The cash creditor's claim is in respect of advances commenced in November last and also a charge on a book debt, but the question of the validity of such charge has to be determined. The lease of debtor's premises has 14 years to run from March 1919, at an annual rental of £200 and for which the debtor paid £200. In connection with the doubtful and bad debts, debtor incurred two heavy losses during the last six months, and it is expected that very little, if anything, will be obtained. The deficiency as regards the statement of affairs is more than accounted for by this loss on the book debts. Debtor commenced business in November, 1918, in Cannon-street, and subsequently, in consequence of the developments of his business, removed to the Hans-street address. No constructive offer was before the meeting. It was resolved that debtor be asked to file his petition in bankruptcy failing the withdrawal of the Sheriff in the action taken by Messrs. Bliss & Company, that upon Sheriff's withdrawal the deed of assignment executed in favour of Mr. Osborne be confirmed, and that a committee of inspection be appointed, consisting of Messrs. L. A. Hindley, J. R. Roose (International Electric Company) and H. Adams (Siemens Bros. Dynamo Works, Ltd.). The liabilities amount to £4,473, of which £4,325 10s. is represented by unsecured trade creditors, the assets (stock, plant and machinery, furniture, good book debts, &c.) amount to £3,163, and the estimated deficiency is £1,307 10s. 11d.

Patent Record.

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

November 11, 1919.

27,8[illegible] W[illegible]fe. Electrical automatic photographic machine.
27,834 Vickers. Trolley-head adjustment.
27,839 Ha[illegible]wen. Ceiling roses for electric lamps, &c.
27,858 Hanst[illegible]ck. Generation, transmission, &c., of electricity.
27,871 Blake & M[illegible]Naught. Carriers for batteries.
27,903 Cl[illegible]n. Combination of two-way switch and transformer.
27,905 Trichar[illegible]. Electric line transmitting apparatus. (13 7 17, France.)
27,909 Osborne. Electric signalling systems.
27,922 B.T.-H. Co. (G.E. Co.) Motor control.
27,933 Prince & Waterhouse. Electric control of air brakes.
27,938 White. (U.S. Light & Heat Corpn.) Dynamo-electric machines.
27,940 White. (U.S. Light & Heat Corpn.) Battery plates and plate pasting machines.
27,941 White. (U.S. Light & Heat Corpn.) Electric regulators.
27,942 White. (U.S. Light & Heat Corpn.) Systems of electrical distribution.
27,948 Mansell. Regulating switches of multiple-contact type.
27,950 Pickin & R[illegible]bb. Wireless telegraph receiving systems.

November 12, 1919.

28,006 Th[illegible]mpson. (Challet.) Electrically-operated sound warning devices.
28,029 Mitchell & Popplewell. Trolley or collector wheels for electric tramways, &c.
28,046 B.T.-H. Co. (G.E. Co.) Electric braking systems.
28,087 Telephone Mfg. Co. & Murray. Telephone receivers and earpieces.

November 13, 1919.

28,107 Rochford. Electric illuminating devices for theatrical stages, &c.
28,154 M[illegible]nd. (International Precipitation Co.) Apparatus for electrical treatment of gases.
28,157 Carey-Gavin Synd. & Carey. Alternating-current motors, &c.
28,192 York. Apparatus for carrying accumulators on motor-bicycles, &c.
28,188 For[illegible]. Accumulators.

November 14, 1919.

22,268 Finlayson. Pocket flash lamp case.
28,265 Eiken. Appliance for regulating hardness of Röntgen-ray tubes.
28,307 British Electric Transformer Co. & Sims. Electric couplings.
28,324 Tilney. Magnetos.
28,330 Scott-Taggart. Thermionic devices.
28,240 Gray. Electromagnetic apparatus for steering vehicles.
28,246 Amberton & Walton. Automatic controlling switches for charging accumulators.
28,249 Lane. Electrical device for holding cog on armature spindle of electric motor starter while it is drawn into mesh with cog on flywheel engine.
28,250 Bolitho. Electric signal recording apparatus.
28,251 Bolitho. Receiving or recording telegraphic messages.
28,260 Goold. (National Safety Appliance Co.) Means for controlling operative field of magnets.
28,291 Ram. Couplings for magnetos.
28,301 Hughes & Turner. Receivers for wireless telegraphy.
28,313 Malcolm. Electric switch devices for preventing use of motor vehicles.
28,318 Holst & Oosterhuis. Conductors for electric lamps, &c.
28,320 Mullard. Thremionic or oscillation valves.
28,325 Jensen & Tilney. Electric ignition for engines.
28,321 O'Neill. Electrical indicating devices.
28,315 Schroder. Electrical seam welding machines. (8/6 18, Germany.)

November 15, 1919.

28,335 Scott-Taggert. Electron discharge devices, &c.
28,369 Automatic Telephone Mfg. Co. & Hudd. Electric relays.
28,383 Brown. Holders for electric lamps.
28,384 Puckette. Regulation of voltage of dynamos.
28,388 Siemens & Halske A.G. Fixing arrangements for electric measuring instruments. (23 8 18, Germany.)
28,393 Imray. (Eisemann Magneto Corpn.) Combined magneto and dynamo-electric machine.
28,390 Parnell & Smith. Electric heating devices.
28,398 Metropolitan-Vickers Electrical Co. Valve operating gear.

November 17, 1919.

28,448 Siemens-Schuckertwerke. Control of asynchronous motors. (31 8 18, Germany.)
28,449 Burdon. (Siemens & Halske A.G.) Electric thermo elements.
28,461 Barbar & Hoyle. Electric couplings.
28,478 Schroder. Electric seam welding machines. (12 6 18, Germany.)
28,499 Pintsch. Electric gas lamps with glow discharge. (27/10 17, Germany.)
28,500 Pintsch. Electric gas lamps with glow discharge. (6/11/17, Germany.)
28,501 Pintsch. Electric gas lamps with glow discharge. (12 12 17, Germany.)
28,507 Nobuhara. Rotary electric machines.

November 18, 1919.

28,518 Murray. Phonio motor drive for telegraph machines.
28,529 Sunderland. Trolley heads for overhead electric tramcars, &c.
28,543 Plumb. Field magnet for dynamo-electric generators and motors.
28,567 Cable Accessories Co., Reeves & Crawford. Fuses.
28,596 Soc. de Moteurs a Gaz et d'Industrie Mecanique. Cooling electric dynamo machines and transformers and recovering waste heat therefrom. (14/10 18, France.)
8,599 B.T.-H. Co. (G.E. Co.) Transformers.
8,600 B.T.-H. Co. (G.E. Co.) X-ray apparatus.

November 19, 1919.

28,628 Garrett. Safety controlling gear for electrically-propelled vehicles.
28,648 Wright. Electric switch for alarm, &c., clocks.
28,649 Hendle. Electric baling presses.
28,653 Armstrong. Carrying and covering electric wires.
28,658 Glanvill. Alternating-current dynamos for lighting.
28,678 Barber. Switches.
28,679 Barber. Couplings.
28,695 Jaggi-Zumbuhl. Controlling electrically heated apparatus. (21 6 19, Switzerland.)
28,706 Laws[illegible]n. Electricity meters.
28,718 Barkway. Automatic control of electric lights in railway carriages.
28,719 Weld[illegible]n. Locking device for magneto circuits.
28,725 Cunningham. Hollow base electric winches.
23,730 Henley's Telegraph Works Co., Dunsheath & McArthur. Electric conductors.
28,742 Soc. Anon. des Ateliers de Secheron. Electrical resistance heater for high temperatures. (6/12 18, Switzerland.)
28,743 & 28,744 Soc. Anon. des Ateliers de Secheron. Electrical resistance heat for high temperatures. (12 2 19, Switzerland.)
28,762 Burgess Battery Co. Dry cells. (19 11 18, U.S.)
28,765 Leechman. Electric torches for walking-sticks, umbrellas, &c.
28,766 Chrisp. Fuse adaptor for portable electric lamps, &c.

November 20, 1919.

28,768 Rickets. Wireless apparatus.
28,772 Baden-Powell. Primary batteries.
28,785 Stenberg & Tayl[illegible]r. Apparatus for making and breaking electric circuits.
28,788 Metropolitan-Vickers Electrical Co. Ventilation.
28,796 Shanahan. Contacts for switches, fuses, &c.
28,797 Firth & Stapleton. Devices for preventing removal of incandescent lamps from their holders.

Companies' Reports, &c.

The profit of the Clyde Valley Electrical Power Company for 1919 was £135,751, and, with £23,335 brought forward, the total is £159,086. The directors recommend a final dividend at rate of 6 per cent. per annum on the ordinary shares for the second half of the year, making 5 per cent. for the year (as in 1918), carrying forward £58,302.

The report of the Mackay Companies for the year ended Feb. 1, 1920, states that the income from investments in other companies amounted to $5,021,094. Operating expenses, including Federal income-tax, transfer agents, registrars, auditors' and trustees' compensation, &c., amounted to $641,883. The dividends paid absorbed $4,355,988, leaving $20,223 to carry forward.

At the meeting on Tuesday it was reported that the net revenue of the North Metropolitan Electric Power Supply Company for 1919 was £62,381, and with interest and dividends and amount brought forward the total is £68,189. After providing for mortgage and debenture interest and transferring £2,000 to debenture reserve the directors propose a dividend on six per cent. cumulative preference shares, and a dividend at the rate of 4½ per cent. per annum on the ordinary shares, leaving £2,041 to be carried forward.

At the meeting of the Rangoon Electric Tramway & Supply Company, Ltd., last week it was reported that the profit for the past year was £89,356, an increase of £11,695. After providing for debenture interest, the preference dividend, &c., the directors recommended payment of a dividend on the ordinary share capital of 7 per cent., leaving £4,360 to carry forward. The chairman referred to the proposal to remove the headquarters of the company to Rangoon, and said the directors would resign in favour of a local board of gentlemen, who, being on the spot, and intimately connected with Rangoon, were well fitted to carry on the work that the English board had hitherto conducted with uniform success. After April 1 the company would be represented in London by Messrs. R. Lawrence Spicer & Company, as London agents.

The report of the County of Durham Electrical Power Distribution Company, Ltd., for 1919 states that the total connections at the end of the year (including connections of the County of Durham Electric Power Supply Company) amounted to 136,895 h.p., compared with 130,086 h.p. in 1918, or an increase of 6,809 h.p. The profit is £80,575, and with balance brought forward (£4,342), the total is £84,917, against which has been charged interest on loans and debenture stock (£12,514), leaving an available balance of £72,403. The directors recommend payment of a dividend of 18 per cent. for the year on the ordinary shares (£72,000), carrying forward £403. The expenditure on capital account during the year amounted to £8,384.

At the recent annual general meeting of the Paisley District Tramways Company it was reported that the revenue for the year 1919 was £126,530 and the expenditure £100,238. After paying interest on debentures, &c., and providing for the debenture sinking fund and adding £6,072 from 1918 the available balance was £21,767. A sum of £6,000 was placed to general reserve account, and after paying the dividends on the cumulative preference shares and placing £2,000 to the preference share sinking fund the balance (£6,267) was carried forward. The traffic receipts increased by over £5,454, but the expenditure increased by £20,418 caused by a further rise in wages, the shorter number of hours now being worked, and to the further great rise in the cost of materials.

Mr. R. C. Longridge presided over the meeting of the British Engine, Boiler & Electrical Insurance Company, Ltd., on 18th inst., and said the directors recommended payment of a final dividend of 8s. 6d. per share, and the usual bonus of 4s. (both less tax), which would absorb £8,925. The company had again achieved a record increase in the volume of business transacted, the premiums and fees for 1919 amounting to £208,90 , compared with £174,162 in 1918, but whilst the growth of business was gratifying the final result could scarcely be considered as satisfactory, as there was a falling-off in the profit earned, the costs of working having risen more rapidly than the premiums. Apart from the cost of repairs, the salaries of the staff had been put on a higher basis to meet the new conditions. In view of the prevailing conditions, the Board decided during the year to establish a subsidiary company under the name of British Electrical Repairs, Ltd., for carrying out repairs to insured electrical plant.

Presiding over the meeting of the Bournemouth & Poole Electricity Supply Company, Ltd., last week the chairman (Mr. J. A. Hosker) said that they were increasing the dividend on the ordinary shares from 5 per cent. to 6 per cent., after providing £8,000 for depreciation (as in 1918) and increasing the carry forward from £1,298 to £4,628. The improvement was all the more pleasing as, being mainly a lighting company, they were working under Government restrictions imposed during the greater part of the year and were subject to higher coal costs and increased wages and salaries. Receipts from sale of current and meter rentals increased by £12,201, or 16 per cent., and interest and dividends receivable by £1,185. The total working costs were £60,521, an increase of £10,844, mainly in respect of coal and other fuel, which increased by £3,111, though salaries and wages increased by £2,468 and repairs by £2,651. The cost of fuel burnt had increased 10 per cent. There had been an increase in capital expenditure of £9,473, and a slight increase in investments due to further advances to the Richmond Company. Practically the whole of the year's capital expenditure had been provided out of revenue. Applications representing 1,695 kw. had been secured, compared with 425 kw. last year. Their trading department made a net profit of £3,393 (against £1,331). The number of men employed by the trading department had trebled owing to growing demands for wiring.

Mr. J. B. Braithwaite presided over the meeting of the City of London Electric Lighting Company, Ltd., last week, and stated that the past year was the most difficult one the company had ever been through. There had been a series of strikes and labour difficulties generally almost continuously throughout the year. A great deal of the time and energy of the directors and officers had been taken up in connection with the Electricity Bill, and they had had great difficulty with their coal supply. In all the circumstances they had some reason to congratulate themselves on being able to present such a relatively good statement. The gross revenue amounted to £521,115, an increase of £134,707, but that increase had been very largely absorbed by increased costs. They carried £179,991 to net revenue account. Great activity had prevailed in the City, and a great increase of business had come to the company in the latter months of 1919, resulting in the sale of 4,599,693 additional units. They were therefore able to make a reduction to their customers on the extra charges put on for war expenses. With the uncertainty of the outlook they could not make a further reduction in the price at present. They were raising the dividend from 8 to 10 per cent., and in addition to that they were restoring two years of the war-rate to the 10 per cent. basis, which would take the form of a bonus of 3 per cent., and would still leave two years to be made good on a future occasion. The total amount provided for depreciation from revenue and other sources from 1901 to 1918 was no less than £1,161,314. In other words, they had carried on the affairs of the company for 19 years without making any further capital issue. Referring to the Electricity (Supply) Act, he said their own company, owing to its central position and the abundant supply of condensing water, was in a position to aid very materially in the provision of a comprehensive supply for the London area. The directors had placed orders for large generating units, which would enable them to provide for the growth of the company's own business, and to give bulk supply to neighbouring undertakers pending the completion of the super-power house down the river, which it was anticipated would form a feature of any comprehensive scheme put forward. The board had entered into an agreement with the County of London Electric Supply Company for the supply of a considerable amount of current in bulk, and it was hoped to have that supply available by the end of the year. In his opinion the only chance of cheapening the supply of electricity in the London area was by utilising and co-ordinating the resources of the existing companies. Their engineer estimated that it would be possible to put down additional plant at Bankside to increase the capacity up to 100,000 kw. If proper security was given for the capital outlay the company would be able to save the whole of London from running short of electricity supply during the next three or four years. Their own business continued to show extraordinary expansion, and the demand showed no signs of slackening. With the additional revenue derived from the bulk supply he looked forward with confidence to the results of the present year's working.

NEWCASTLE-UPON-TYNE COMPANY MEETING.

Addressing the shareholders of the Newcastle-upon-Tyne Electric Supply Company, Limited, at the annual meeting last week, the chairman (Mr. J. A. Armstrong) said that they were again paying an 8 per cent. dividend on the ordinary share capital, after transferring £30,000 to reserve for plant renewals and improvements, against £40,000 last year. The expenditure on plant maintenance had been charged direct to costs, and represented a total sum of £137,392 (against £118,500 in 1918), mainly due to the rise in wages and materials. They had now in commission some of their newer and more economical plant, and they looked forward to having further sections of the plant available. They were thus in a favourable position to deal with any loads they were likely to be called upon to meet. The charts indicated a steady improvement compared with last year. The effect of the moulders' strike was still felt. The applications on hand at present represent 82,900 h.p., which showed a substantial increase over 12 months ago. The directors had every reason to hope for a considerable improvement in output during the next nine months, and, provided that nothing further occurred to interfere with the efforts by their large customers to increase production, they should be able to meet next year under happier circumstances.

Mr. R. P. Sloan, C.B.E. (the manager) who referred to the effect of the Electricity (Supply) Act, said the Commissioners were men of great experience in electrical matters, and there was no doubt that they would enjoy the confidence of the whole of the electric supply industry. Although the company was the pioneer public electric supply undertaking in the kingdom to introduce the three-phase alternating-current system of supply, adopting a periodicity of 40 cycles per second as its standard, many independent undertakings on the north-east coast which came into existence in later years adopted different alternate current systems and periodicities. The extension of their system, and the linking up to it of one undertaking after another, had necessitated the expenditure of many thousands of pounds in changing over from the existing systems of supply to theirs. In the Cleveland Company's undertakings there were three distinct systems of supply, none of which was the same as theirs. Had the Board of Electricity Commissioners been in existence in the past the multiplicity of generating stations and the extraordinary difference in the systems of generation throughout the country would not have been permitted. The setting up of Joint District Councils in various areas throughout the country would afford opportunities of bringing together the employers and workmen in the industry, and enable them to discuss and settle questions affecting working conditions, wages, &c., in a prompt and equitable manner. The general feeling of uncertainty which had prevailed throughout the country was reflected in the comparatively small connections made to their system during the last 12 months—namely, 7,686 h.p. The tests recently carried out on the sections of their new generating plant so far completed had proved that the anticipated economies would be fully realised as the plant was brought into commercial operation. The applications on hand (82,900 h.p.) represented approximately 20 per cent. of the total connections to the system of the Newcastle Company and its associated companies since the commencement of their operations, and considerably exceeded the disconnections which had taken place as a result of the stoppage of munitions manufacture, and unless some unforeseen circumstances arose there was reason to believe that the new connections made during the current year would equal the maximum horse-power connected in any previous year. The increase in output since the commencement of the current year, compared with the corresponding period of last year, was a distinct indication that their position was improving, and that, coupled with the large demands, augured well for the future. With regard to the proposed main line electrification scheme of the North-Eastern Railway, which represented the electrical equipment of some 120 route miles of the company's main line system, he hoped that before long that scheme would mature.

METROPOLITAN-VICKERS MEETING.

Mr. J. Annan Bryce presided over the meeting of the Metropolitan-Vickers Electric Company, Ltd., on Monday, and stated that the available profit for the past year was £320,659, an increase of £74,085 over 1918. After providing for debenture interest, &c., and appropriating sums to special depreciation of plant, &c., and to general reserve, and paying the dividends on the preference and ordinary shares, there was a balance to be carried forward of £51,089. The orders received during the year exceeded those of 1918 by about 20 per cent., and the value of orders on hand exceeded those at the end of 1918 by about the same percentage. The orders received during the first two months of 1920 were nearly thrice as large as those taken during the same period of 1919; but while it was gratifying to know that the demand for the products was increasing so fast, he warned the shareholders against forming any estimate of results on the increase in volume of business. In former days work in progress represented a larger percentage of the total cost of products sold than it now did.

Labour and Supplies.

In the course of his reference to the moulders' strike, he stated that the relations between the management of the company and the moulders were perfectly satisfactory. The strike had militated seriously against the country's quick recovery from the war, and unhappily its evil effects would continue to be felt for many months to come. While they had so far been exempt from individual trouble, the difficulties inherent in the general attitude of labour affected them, as they did all industries. There was a large drop in the output per man employed. Many causes were involved, but the management was convinced that the shortening of the working hours had had a direct influence on that result, as they were producing less per man per hour than they did formerly. The number of men and women workers (exclusive of the staff) was 4,791 on Dec. 31—nearly 2,000 less than it was before the moulders' strike. The numbers were gradually being built up again, and at present reached 5,700—a figure, however, which was inadequate for the business. The difficulty in securing the requisite number of skilled men was partly caused by the housing question. The average weekly earnings had risen as follows during the period 1912-1919:—Males, from 27s. 6d. to 61s.; women, from 12s. 3d. to 37s., the figures including boys, girls and night shifts. The delay in the supply of material was not so serious since the removal of Government restrictions, but was still so considerable as greatly to hamper the programme of work. Concentrated efforts had been made to speed up their suppliers by special appeals, and the position showed signs of improvement. If they could surmount the difficulties outlined and succeeded, with the aid of the large capital expenditure now being incurred, in providing the increased plant necessary to handle the largely increased orders, the management looked with confidence to the future.

New Manufactures.

The company had in the last few years embarked on several new lines of manufacture. They were extremely well equipped to undertake large electrical work for railways, municipal bodies and other large users, whether in the way of complete generating power plant or other electrical equipment. They had just taken from Manchester Corporation an order for two 25,000 kw. sets for its new super-power station. Within the last year or two they had turned their attention to the production of marine turbines. In addition, they had separate departments with complete expert engineering staffs for the manufacture of water-wheel generators, condensing plants, rolling-mill equipments, large and small electric motors (both alternating and direct current) for all industrial purposes, tramway motors, electric winding plant for mines, h.t. and l.t, switchgear, electric meters and recording instruments, transformers, including furnace transformers and rotary converters. In connection with the subsidiary companies, they were also manufacturers of electric lamps, and were just about to commence the manufacture of certain lines of heating and cooking apparatus. The company's products were very largely supplied, not only to municipal corporations, railway companies and great industrial concerns in this country, but also to those on the Continent and in the Overseas dominions. The labour situation was the real crux of the period of reconstruction. He was so convinced of the innate good sense and good feeling of the British people that his mood had in it no touch of despair. He believed the sole permanent remedy for the distrust which was at root of the trouble was an identification of interests, whether in the form of payment by results or sharing of profits.

New Companies.

ALDEN ENGINE COMPANY, LTD. (165,349).—Private company. Reg. March 17, capital £20,000 in £1 shares. To carry on the business of mechanical, electrical and general engineers, manufacturers of internal combustion engines, &c. First directors are: F. G. Alden, W. J. Banks, H. S. Critchley and G. D. Barlow. Reg. office: Crown Works, Cornmarket-street, Oxford.

R. P. BOYD & COMPANY, LTD. (165,423). Private company; reg. March 18, capital £10,000 in £1 shares, to carry on the business of manufacturing, electrical and mechanical engineers, manufacturers and workers of metals, wood, porcelain, &c. First directors are J. M. Newton, R. P. Boyd and G. H. Sherrow. Reg. office, Hooper-street, Birmingham.

CECIL CCOPER & COMPANY, LTD. (165,356). Private company. Reg. March 17, capital £20,000 in £1 shares. To take over the business of engineers carried on at 14, Gloucester-road, London, and at Bournemouth. First directors are: C. J. Cooper and S. W. Cooper. Reg. office: 28, Budge-row, E.C.4.

COLONIAL & FOREIGN GLASS INDUSTRIES, LTD. (164,843).—Reg. March 5, capital £750,000 in £1 shares, to carry on the business of manufacturers, merchants, importers and exporters of glass, including glass, electric lamp bulbs, bulbs for miners' lamps, wireless telegraphy and lamps, &c. First directors are: C. C. Hatry, P. J. Mitchell, T. B. Kitson and L. Owry. Reg. office: 6, Austin Friars, E.C.

GWYNNES ENGINEERING COMPANY, LTD. (165,547.)—Reg. March 22; capital £600,000 in £1 shares. (There is also to be £300,000 7½ per cent. debenture stock, redeemable at 105 per cent. in December, 1939.) Objects, to acquire the business of Gwynnes, Ltd., certain property at Hammersmith and Chiswick; the issued share capital of Adam Grimaldi & Company, Ltd., &c. First directors are Sir Byron Peters, K.B.E., M.I.Mech.E., Jas. M. Dewar, M.I.N.A., M.I.Mech.E., Nevile G. Gwynne, M.I.N.A., M.I.Mech.E. (managing director), J. G. Mair-Rumley, and W. W. Wilkes. Reg. office, Hammersmith Iron Works, Crisp-road.

KEIGHLEY LABORATORIES, LTD. (164,811). Private company: Reg. March 4, capital £5,000 in £1 shares (1,000 founders'). Objects: To carry on at Keighley and elsewhere the business of metallurgical and general commercial analysts for mechanical and physical tests of manufactured or raw material, electrical tests, heat treatment and case hardening of metals, &c. Reg. office: Croft House, South-street, Keighley.

MACROOM ENGINEERING COMPANY, LTD. (4,908)—Private company. Reg. in Dublin Feb. 14, capital £12,000 in £1 shares, to carry on the business of founders, machinists, manufacturers and electrical engineers, &c. First directors are: F. A. Horgan and R. A. B. Heap. Reg. office: Macroom, co. Cork.

MAGNETIC TRANSMISSION COMPANY, LTD (165,420).—Reg. March 18, capital £300,000 in £1 shares (195,000 preferred ordinary). To take over the right to manufacture and sell in the U.K. the system of power transmission known as the "Eatry Magnetic Transmission," together with the right to export motor cars after the same have been completed and the entry transmission installed therein, or any other article for which the said transmission may be useful, and to adopt an agreement with the Crown and the Owen Magnetic Transmission Syndicate. J. L. Crown, Gwydyr Mansions, Hove, is the first director.

Prices of Metals, Chemicals, &c.

TUESDAY, March 30.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£114 0 0	—	£2 0 0
Electro Wirebars...	,,	£115 0 0	—	£3 0 0
H.C. wire basis......	per lb.	1s. 3⅝d	—	$\frac{5}{16}$d.
Sheet................	,,	1s. 5$\frac{13}{16}$d.	—	$\frac{3}{16}$d.
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7⅝d.	—	$\frac{5}{16}$d.
Brass 60/40—				
Rod, basis	,,	0s. 11⅝d.	—	¼d.
Sheet, basis	,,	1s. 4½d.	¼d.	—
Wire, basis	,,	1s. 4d.	—	¾d.
Iron—				
Cleveland Warrants	per ton	£10 7 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£47 0 0	£3 10 0	—
Lead Pig—				
English	,,	£43 0 0	—	£5 0 0
Foreign or colonial	,,	40 5 0	—	4 15 0
Tin—Ingot	,,	345 10 0	—	9 10 0
Wire, basis	per lb.	0 4 3½	—	1½d.

Salammoniac.—Per cwt. 105s.–100s.
Sulphur (Flowers).—Per ton £22.
,, (Roll Brimstone).—Per ton £22.
Sulphuric Acid (Pyrites, 168°).—Per ton. £8 8s. 9d.

Copper Sulphate.—Per ton £48.
Boric Acid (Crystals)—Per ton £74.
Carbon Bisulphide.—Per ton £56
Sodium Bichromate.—Per lb. 9d
Sodium Chlorate—Per lb. 5½d.

Rubber.—Para fine, 2s. 4d.; plantation 1st. latex 2s. 2½d. per lb
Shellac.—T.N. Orange, 700s.

The metal prices are supplied by the British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co., Ltd.

Forty Years Ago.

(THE ELECTRICIAN, APRIL 3, 1880.)

PROTECTION OF TELEGRAPH WIRES.—The Prussian Director-General of Telegraphs has requested all schoolmasters within the kingdom to instruct their scholars not to damage the telegraph wires in any way or form.

USE OF THE TELEPHONE AS A GALVANOSCOPE.—In a communication to "La Lumiere Electrique," Lieut. M. des Portes points out that when an interrupted current is transmitted through a Bell telephone the sound produced is under certain conditions stronger when the current is direct, or in the same direction as the hypothetical currents in the magnet, than in the contrary case.

VERY CONSIDERATE!—Our erratic French contemporary, "L'Electricité" (March 5) says:—"We see with pain that certain French scientific journals have noticed and illustrated certain articles on the Birmingham Wire Gauge. Every innovation tending to retard the disappearance of feet, inches, lines, gallons, pounds, &c., will be banished from these columns as unworthy to figure in a serious scientific publication. The best service that we can render to the English scientific men is to bury in silence this proof of their ignorance."

TRANSMITTING LIGHT BY ELECTRICITY.—A patent for the purpose of transmitting scenes to a distance by means of electricity has been applied for at the U.S. Patent Office by Messrs. Connelly Brothers and M'Tighe, patent agents, Pittsburgh. The inventors believe that two persons talking by telephone will also, by their device, be able to see each other, and that a printed or written document can be seen in this way and read off. A single wire is required to transmit a diminutive image, which is magnified at the receiving station. Here, if anywhere, seeing is believing.

THE MORSE ALPHABET IN DANGER.—An American, Mr. C. G. Burke, proposes a telegraphic alphabet founded upon musical notation, viz., a system of lines and spaces. He suggests having three lines and two spaces, and uses dots and dashes to represent the characters of the ordinary alphabet. The position and the number of the dots or the dashes indicate the equivalent in the Burke vocabulary.

USE OF ELECTRIC LIGHT FOR NAVIGATION DURING THE NIGHT TIME.—The Rouen papers give the following details of an experiment in night navigation, which was carried out on the Seine by the aid of the electric light. At half-past eight p.m. the Furet took on board almost all the members of the Chamber and of the industrial commission, together with some of the invited guests. A Gramme dynamo-electric machine, worked by a small Brotherhood motor of from one to one and a-quarter horse power, had previously been placed on board. This served to produce a luminous beam which, by means of a movable parabolic reflector, threw its light to a distance of more than a kilometre upon the path to be taken by the vessel. Starting from the creek of St. Eloi, the Furet, taking the right arm of the river, went up stream successively through the Pierre-Corneille and railway bridges, followed the left bank as far as the Rodet Island, and then returned to the starting point. The light worked uninterruptedly during the whole distance, illuminating at a distance every obstacle, searching, so to speak, the river in front of the vessel, and throwing a clear light upon every point that the watch thought worthy of attention. Thanks to this new application of the electric light the security of the navigation of the lower Seine will be greatly enhanced during the night, a result which cannot fail to be of benefit to constantly extending traffic of the port of Rouen.

EXTRACT FROM A DISCUSSION ON "THE ELECTRIC LIGHT AND ITS PARENTS."—After a very full statement from various quarters, the general conclusion arrived at was one which Mr. Alexander Siemens, in his reply, summed up in words which, briefly stated, amount to this:—"Electric lighting is very good where it is suitable, and very cheap where the conditions for producing it are favourable." Mr. Siemens proved himself to be no special pleader or partisan, but an advocate who, while doing his duty by his client did not undervalue his opponent's case. Indeed, he concurred in the general conclusion that, for large spaces only, or for limited spaces where machinery already existed, could the electric light be introduced economically.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics":—"Cairo-Cape Flight," by Major C. C. Turner; "Subsidies"; and "Direction Finding by Wireless."

"Cabinet Maker":—"Weaving of Cane and Willow by Machinery"; "The Cutting of Loose Covers (VIII.)"; "Colour Schemes for the Home."

"Chemical Age":—"Effects of Explosion on Chemical Plant" (Illustrated); "Constitution of Inorganic Compounds," by Professor G. T. Morgan; Sir J. Dobbie's Presidential Address to the Chemical Society.

"Fruit Grower":—Conference at Wye College; "Work and Wages," by E. J. P. Benn; "Bird Life and Food Production."

"The Gas World":—"Conservation of Heat in Gas Manufacture"; "Correct Use of Gas"; and special section dealing with the By-Product Coking in Industry.

"Hardware Trade Journal":—"Sale of Agricultural Machinery"; "Hardware and Engineering in Italy"; and "Labour Saving in the Foundry (VII.)," by Joseph Horner.

"Ways and Means":—"Insurance as a Branch of Welfare Work," by the Editor; "Thirty Years of Profit Sharing," by H. Cooper; and "Labour Saving in the Home," by Mrs. Sanderson Furniss.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,186. [Vol. LXXXIV. No. 15.] FRIDAY, APRIL 9, 1920. PRICE ONE SHILLING. By Post, 1s. 1d. Abroad, 1s 2d.

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Notes.

Profiteering and the Electric Lamp Industry.

THE Electric Lamp Manufacturers' Association have addressed a letter to the PRIME MINISTER on the subject of the price of lamps, in which certain statements made by the Sub-Committee of the Standing Committee on Trusts are traversed. The principal points in this letter will be found summarised on another page of this issue. It is unnecessary for us to comment on them in detail, for the reason that we did not take the report of the Committee without the condiment necessary on these occasions, and have already pointed out that where it did not actually praise the Association by implication for building up safeguards against foreign competition it made strictures which were based on an imperfect knowledge of facts. There are, however, one or two little matters which may, with advantage, be rubbed in. Profiteering may be roughly said to be the acquirement of an unjustly high return on trading activities, the market in 1913 being taken as a standard. Applying this definition in this case we find that the average profits of the Association firms dropped from 9·5d. per lamp in 1913 to 4·7d. in 1919. In spite of the greatly increased cost of production the rise in the retail price of lamps has, in these six years, only been about one-fifth of the general rise in prices, while even the Sub-Committee admit that higher prices could have been obtained. Was this profiteering? We may be forgiven if we do not pause for a reply. Another point to which reference may be made is the charge that the three largest firms in the Association had limited output by restricting the granting of licences, and by making stipulations that the validity of their patents should not be disputed. In reply to this the Association quite rightly points out that every patentee is granted a monopoly, and should not, therefore, be attacked if he uses the power thus legally implied. The Association granted licences, and the only point at issue then is how far the combination of patentees is equitable, and whether it should be prevented. If no trade association uses the power given by its patents more rigorously than the Electric Lamp Manufacturers' Association has done we are sure it will be agreed that a combination of interests is better than the alternative of Government control. The Electric Lamp Manufacturers' Association has not only not refused licences, but has offered them to all existing manufacturers, so that they can hardly be found guilty of undue restraint of trade on this count, while it is absolutely denied that anything has been done to prevent a trader buying non-Association lamps and selling them, if he wishes, more cheaply than Association lamps.

Research in Industry.

THE allegation regarding the undue profits made on a certain batch of imported Dutch lamps is also explained, but we have already dealt with this point. Further reference may, however, be made to the large amount of research and experimental work carried out by the Association, and to the necessity for such work in the development of a cheap and efficient electric lamp. Our foreign competitors are working on scientific lines, and we must do the same. It should be noted that this same Dutch transaction would never have been carried out had not the British electric lamp industry been unable to manufacture lamps in a number sufficient for the needs of the various Government departments. This inability to manufacture was due to no supply of argon being available on a commercial scale. A process for ensuring such supply had been invented and perfected by Dutch enterprise, and part of the price of building such a plant over here was the permission to import a certain number of Dutch lamps. The necessity was urgent; the offer was closed with, and a charge of profiteering is the result. But the important point to notice is that research must go hand in hand with industry if progress is to be made. The best brains must be enlisted to discover the best methods of manufacture, to test them ruthlessly, and to scrap them if necessary. This process must be a continuous one, until perfection or something near it is reached. Such a policy is deserving of praise, but it requires money, and it also should predicate a reasonable return for enterprise. These considerations seem to be among those the Sub-Committee overlooked.

The Coal Situation.

THE past fortnight has witnessed a series of undignified haggles between the Government and the Miners' Federation. To meet the increased cost of living, the latter demanded for their members an increase in wages of 3s. per shift for men and of 1s. 6d. per shift for boys. In reply to this, the Government offered an increase of 20 per cent. on the standard wage, excluding the war wage and the "Sankey wage." Alternatively, they offered an increase of 1s. 6d. per shift for men and 6d. per shift for boys. The Federation next suggested that the wages should be increased by 22½ per cent., with a minimum of 3s. per shift, for men, 2s. per shift for boys over 16 and 1s. per shift for boys under 16. The Government countered this by sticking to their suggestion of a 20 per cent. increase, with the modification that a minimum of 1s. 6d. per shift for the men and 9d. per shift for the boys would be guaranteed. They subsequently made a third offer, guaranteeing a minimum of 2s. per shift for men, 1s. per shift for boys over 16, and 9d. for boys under 16. Upon the acceptance or rejection of this offer the Federation have decided to seek the advice of their members: a ballot is being taken, the result of which will be announced on April 15th, and, as far as indications go at present, the voting seems about equally for and against acceptance. We do not propose to discuss the rights and wrongs of this matter at any length: but it is at least arguable that the miners are at present receiving adequate wages, and it is further obvious that the concessions they have wrung from the Government have been obtained more by the political influence of their numbers than by the righteousness of their claims. It is a state of affairs to make the wise grieve. Whatever the result of the ballot, one thing is certain there will be a further increase in the cost of production of commodities and a postponement of the time when financial and industrial stability will be reached. The worst feature about the whole thing is that there is every prospect of fresh demands being made, the movement being avowedly of a political character.

The Tramway Strikes.

The threatened thunderstorm in the form of an Easter tramway strike seemed to be moving away when we went to press last week: but, like the atmospheric conditions, matters took a change for the worse during the holiday, and, although there was no general cessation of work, there were local stoppages at Manchester, Salford, Oldham, Huddersfield, Cardiff and Swansea. At all these places, except the last named, the strike still continues. A strike could not be arranged at such a time without a realisation of the inconvenience it would cause to holiday makers, and we are not surprised to learn that the opinion of those who could not get to Castle Irwell races on Easter Monday, except by walking, was expressed with unparliamentary force. The public are getting a little tired of this sort of thing. These particular strikes are yet another example of the refusal of the rank and file of a Trade Union to accept the settlement negotiated by their leaders, and an indication that the formation of a Whitley Council in an industry will not by itself engender universal peace. As we have said before, no success can be expected from the formation of Whitley Councils unless those sitting on such Councils, and those whom such Councils represent, have a "will to peace." Such a will does not exist at present, nor can be expected to exist on the employee's side when it has for so long been the policy of their leaders to encourage antagonism and to preach that the strike is the only weapon worth using. We are afraid, indeed, that trades union leaders will have to face some anxious moments if strikes are to become the order of the day, whether those strikes are official or unofficial. For while a strike inflicts great damage on the community, it also inflicts great damage on the finances of the trades union concerned, and of the two the former has the greater resilience. This would not, perhaps, be of so great moment if anything were gained by this sort of strike; but as Mr. Appleton, general secretary of the General Federation of Trade Unions, recently said: "The saddest thing about this expenditure (i.e., on strikes) is its failure to secure anything beyond what might have been secured by negotiation and without strikes." We see no reason why these present tramway strikes should be any exception. The men's one real grievance seems to be that they do not get as much as the dustmen!

Civilian War Honours.

One of the results of the War has been to bring about some official recognition of the work done by engineers. Whether this is a good or an evil thing must remain a matter of opinion. But we think it will be agreed that if Honours are to be granted at all, they should be given with more liberality to those who labour in other than political and official fields, and that there should cease to be that neglect, which has been so evident in the past, of those whose work is mainly connected with engineering and scientific achievements. It is these men who make real progress, and the highest honours should be theirs by right. Ethically, there can be no doubt who has deserved the greater reward, the man who has opened the benefits of some wonderful invention to suffering humanity, or the man whose chief activities have been in that underworld of politics which we do not pretend to understand. We felicitate all those connected with engineering who have just received appointment to or promotion in one or other of the classes of the Civil Division of the Order of the British Empire. A full list appears on another page of this issue. Among the Knights Grand Cross may be mentioned the Rt. Hon. Viscount Chilston and Sir John Denison-Pender, who may be taken for our purpose as representing the traction and telegraphic sides respectively of electrical engineering. The Knight Commanders include Prof. W. H. Bragg, Mr. James Devonshire, Mr. George Elphinstone, Mr. Arnold Gridley, Dr. J. E. Petavel and Mr. H. B. Renwick. Numerous other well-known names will be found in the other classes of the Order. To all of them we offer our congratulations, but we are particularly glad to see the liberal recognition that has been paid to railway officials. We hear a good deal of the rights and wrongs of the railway employee, but little of those who hold such positions as chief engineer and goods manager. Their work during the past few years has been superhumanly arduous, perhaps unnecessarily so, and the rewards thus given are not more than their due. This is not the place to philosophise, but there is no doubt that the award of honours and decorations, however much he may protest to the contrary, brings to the recipient a sense of pleasure as of a prize deserved and won. It is trite to say that so many of these honours are now given that they are becoming cheap, and we are by no means in disagreement with those who would like to see all this kind of thing stopped by a sort of Hague Convention. It is equally common to add that there are many who deserve honours and who don't receive them. It would be more charitable to say that all those who do receive them deserve them. That is a point which requires emphasis when this particular list is considered.

Cast Iron Wheels *versus* Steel Tyres.

In the United States it has been the occasional practice to use cast-iron wheels on tramcars, especially on trailer cars, in contradistinction to the usual practice, both in this country and on the Continent, of employing steel tyres. On certain Continental tramway undertakings the desirability of using cast-iron wheels has, however, had to be considered recently owing to the high price which was being asked for steel tyres, and the further difficulty of obtaining them. To employ cast-iron wheels was admittedly an experiment, but it is an experiment which has been justified by results on one particular system at any rate. One of the motor cars which was equipped with cast-iron wheels ran some 10,500 miles in 1919 without showing excessive wear, and on trailer cars this type of wheel has run as much as 53,125 miles in several cases with a wear of about 0·16 in. on the diameter, and they are thus still capable of further service. The only wheel of this kind which gave any real trouble was one on which a flat formed after it had run no less than 58,750 miles, this defect being doubtless due to some defect in the casting. After re-heating, however, it gave further good service. It would therefore seem there is no reason why cast-iron wheels should not be as satisfactory in service as those fitted with steel tyres; and in these days of economy their price has much to recommend them. It is however, a question which can only be satisfactorily decided on the foundation of accumulated experience, and we are therefore glad to see that the Union Internationale de Tramways et de Chemin de Fer d'Interêt Local are asking their members to carry out tests on wheels of this kind, and to communicate the results obtained to the Secretary. A point of special interest in this connection is the frequency of breakage of these wheels and the probable causes.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

Mr. H. H. Broughton contributes another instalment of his serial article on "Electric Winding Engines and Mine Hoists" (p. 390).

We give an account of a Paper by Signor G. Pession on "The Poulsen System of Radio-Telegraphy." This is one of a series of pamphlets on different subjects relating to radio-telegraphy published by the R. Accademia Navale-Livorno (p. 393).

On p. 396 will be found an account of the discussion which took place at Birmingham on the Standardisation Rules for Electrical Machinery.

We conclude our account of a course of lectures delivered by Sir J. J. Thomson, O.M., P.R.S., before the Royal Institution on "Positive Rays" (p. 397).

On p. 399 is a description of Some Modern Electric Welding Machines made by the A-I Manufacturing Company of Bradford.

A description of some of the electrical exhibits at the Birmingham Trades Exhibition will be found on p. 401.

Our Leading Article deals with the new nominations for the Council of the Institution of Electrical Engineers, and points out the desirability of the general body of members taking a larger part in these elections (p. 403). Full particulars of the new nominations are given on p. 405.

A list of recent appointments and promotions to the Civil Division of the Order of the British Empire is given on p. 407.

Our serial article on progress in Electric Heating and Cooking appears on p. 404.

The reply of the Electric Lamp Manufacturers' Association to the recent report of the Sub-committee of the Standing Committee on Trusts is given on p. 406.

On p. 407 will be found an important reserved judgment by Mr. Justice Sargant in the action brought by the British Thomson-Houston Company against the Corona Lamp Works, Ltd., for alleged infringement of letters patent No. 10,918 of 1903, relating to the gas-filled lamp.

Arrangements for the Week.

FRIDAY, April 9th (to-day).

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "The Development and Manufacture of the Thermionic Valve," by Mr. A. H. Howe.

MONDAY, April 12th.

Western Centre of the Institution of Electrical Engineers.

7 p.m. At the South Wales Institute of Engineers, Park-place, Cardiff. Lecture on "Thermionic Valves," by Prof. F. Bacon.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. At the Technical School, Barrow-in-Furness. Paper on "Critical Speeds of Shafts," by Mr. G. E. W. Johnson.

Students' Section of the Institution of Electrical Engineers.

8 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Joint Discussion with the Graduates' Association of the Institution of Mechanical Engineers on "Six Hour Working Day and its Effect on Industry."

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London. Lecture on "Aluminium and its Alloys," by Dr. W. Rosenhain, F.R.S.

TUESDAY, April 13th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. 1. Lecture on "Recent Advances in X-Ray Work," by Major G. W. C. Kaye, O.B.E. (Lecture 1.).

Institution of Civil Engineers.

5.30 p.m. At Great George-street, London, S.W. Paper on "Richborough Military Transportation Depot," by Lieut.-Col. J. K. Robertson, and "The War Department Cross-Channel Train-Ferry," by Major F. O. Stanford, O.B.E.

Institution of Electrical Engineers.—N.-Western Centre.

7 p.m. At the Engineers' Club, Manchester. Annual General Meeting, followed by a smoking concert.

Institute of Metals.—Birmingham Local Section.

7.30 p.m. At the Imperial Hotel, Temple-street, Birmingham. Annual General Meeting and Dinner.

Scottish Centre of the Institution of Electrical Engineers.

7.30 p.m. At 207, Bath-street, Glasgow. Lecture on "Highland Water Power," by Mr. J. M. M. Munro.

WEDNESDAY, April 14th.

Royal Institution.

3 p.m. At Albemarle-street. Lecture on "Recent Advances in X-Ray Work," by Major G. W. C. Kaye, O.B.E.

Royal Society of Arts.

4.30 p.m. At John-street, Adelphi, London. Lecture on "The Fundamental Basis of Good Printing," by Mr. Joseph Thorp.

Association of Engineers-in-Charge.

7.30 p.m. At St. Bride Institute, Bride-lane, Fleet-street, London, E.C. Paper on "Hygienic Principles of Ventilation and Heating," by Prof. L. Hill.

Institution of Automobile Engineers.

8 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Paper on "The Most Suitable Steels for Automobile Parts," by Dr. W. H. Hatfield.

Royal Aeronautical Society.

8 p.m. At John-street, Adelphi. Paper by Major-General Sir W. Sefton Brancker.

THURSDAY, April 15th.

Royal Institution.

3 p.m. At Albemarle-street. Lecture on "Ebullition and Evaporation," by Mr. Sidney Skinner.

Royal Society of Arts.—Indian Section.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Roads and Transport in India," by Brig.-Genl. Lord Montagu of Beaulieu.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Eleventh Kelvin Lecture on "Modern Marine Problems," by Dr. C. V. Drysdale.

FRIDAY, April 16th.

N.-East Coast Institution of Engineers and Shipbuilders.

6.15 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "The Casting and Treatment of Steel," by Dr. J. H. Andrew.

Students' Section of the Institution of Electrical Engineers.

7 p.m. At Faraday House, Southampton-row, W.C. Paper on "The Vacuum Tube as a Transmitter and Receiver of Continuous Waves," by Mr. J. Scott-Taggart, M.C.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "Ions and Nuclei," by Dr. J. A. McClelland, F.R.S.

SATURDAY, April 17th.

Royal Institution.

3 p.m. At Albemarle-street. Lecture on "The Thermionic Vacuum Tube," by Dr. W. H. Eccles.

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(Continued from p. 313.)

Inclined Shafts.

Under this heading, shafts of uniform and varying slope have to be considered. Typical shafts are depicted in Fig. 6, and an example of each will be given.

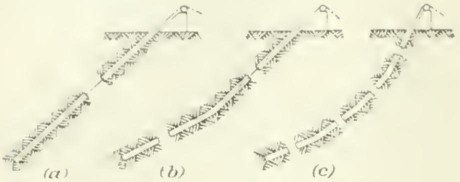

Fig. 6.—Typical Inclined Shafts.

Force Required to Move a Body on an Inclined Plane.—Referring to Fig. 7 (*a*) suppose that a body of weight *W* lb. rests on a plane inclined at θ degrees to the horizontal, and that when the plane is tilted through a certain small angle φ from the horizontal the body just begins to slide down the plane. In other words the coefficient of friction $\mu = \tan\varphi$. For skips on wheels with the track on which they run in good order, the angle φ varies between $2\frac{1}{2}$ and $3\frac{1}{2}$ degrees.

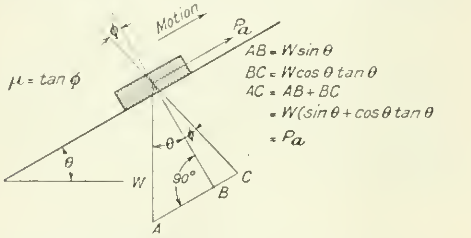

Fig. 7 (a).—Motion up an Inclined Plane.

Then, when the body is moved up the inclined plane by a pull P_a parallel to the plane, we have from Fig. 7 (*a*)

$$P_a = W(\sin\theta + \cos\theta\tan\varphi)\ \text{lb.} \qquad (1)$$

Similarly, to prevent the body sliding down the plane, from Fig. 7 (*b*) it will be seen that a holding-back pull P_d has to be applied such that

$$P_d = W(\sin\theta - \cos\theta\tan\varphi)\ \text{lb.} \qquad (2)$$

The expressions within the brackets of equations (1) and (2) have been calculated for angles of inclination θ varying from 0 to 60 degrees on the assumption that the angle of friction is $3\frac{1}{2}$ degrees. These are set out in Table VII.

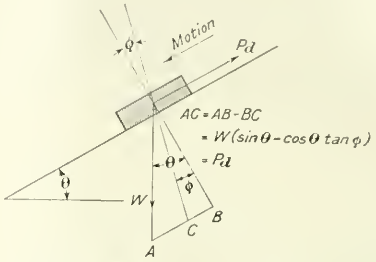

Fig. 7 (b).—Motion down an Inclined Plane.

An example will enable us to show how the table is intended to be used. Suppose a load of 12,000 lb. is to be hoisted in a skip weighing 8,000 lb. up an incline of 38 degrees, and that an empty skip weighing 8,000 lb. is lowered simultaneously. It is required to find the unbalanced rope pull on the winding drum due to the ascending and descending skips.

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Table VII.—*Multipliers for Rope-pull due to Loads in Inclined Shafts.*
(Angle of Friction $\varphi = 3\frac{1}{2}$ deg.)

Angle θ.	Sin θ.	Multiplier for rope-pull.		Angle θ.	Sin θ.	Multiplier for rope-pull.	
		Ascending Sin θ + cos θ tan φ.	Descending Sin θ − cos θ tan φ.			Ascending Sin θ + cos θ tan φ.	Descending Sin θ − cos θ tan φ.
1	0·0175	0·0787	−0·0437	31	0·5150	0·5675	0·4625
2	0·0349	0·0961	−0·0263	32	0·5299	0·5818	0·4780
3	0·0523	0·1134	−0·0088	33	0·5446	0·5959	0·4933
4	0·0698	0·1309	0·0087	34	0·5592	0·6099	0·5085
5	0·0872	0·1482	0·0262	35	0·5736	0·6237	0·5235
6	0·1045	0·1645	0·0336	36	0·5878	0·6373	0·5383
7	0·1219	0·1826	0·0612	37	0·6018	0·6507	0·5529
8	0·1392	0·1997	0·0787	38	0·6157	0·6639	0·5675
9	0·1564	0·2168	0·0960	39	0·6293	0·6769	0·5817
10	0·1736	0·2339	0·1133	40	0·6428	0·6897	0·5959
11	0·1908	0·2509	0·1307	41	0·6561	0·7023	0·6099
12	0·2079	0·2678	0·1480	42	0·6691	0·7146	0·6236
13	0·2250	0·2846	0·1654	43	0·6820	0·7268	0·6372
14	0·2419	0·3013	0·1825	44	0·6947	0·7387	0·6507
15	0·2588	0·3179	0·1997	45	0·7071	0·7504	0·6638
16	0·2756	0·3344	0·2168	46	0·7193	0·7618	0·6768
17	0·2924	0·3509	0·2339	47	0·7314	0·7731	0·6897
18	0·3090	0·3672	0·2408	48	0·7431	0·7840	0·7022
19	0·3256	0·3835	0·2677	49	0·7547	0·7949	0·7145
20	0·3420	0·3995	0·2845	50	0·7660	0·8053	0·7267
21	0·3584	0·4155	0·3013	51	0·7771	0·8156	0·7386
22	0·3746	0·4313	0·3179	52	0·7880	0·8257	0·7503
23	0·3907	0·4470	0·3343	53	0·7986	0·8354	0·7618
24	0·4067	0·4626	0·3508	54	0·8090	0·8450	0·7730
25	0·4226	0·4781	0·3671	55	0·8192	0·8543	0·7841
26	0·4384	0·4934	0·3834	56	0·8290	0·8632	0·7948
27	0·4540	0·5083	0·3997	57	0·8387	0·8720	0·8054
28	0·4695	0·5235	0·4150	58	0·8480	0·8824	0·8156
29	0·4848	0·5383	0·4313	59	0·8572	0·8887	0·8257
30	0·5000	0·5530	0·4470	60	0·8660	0·8966	0·8354

Referring to the table it will be seen that when the angle of inclination is 38 degrees the multipliers are 0·6639 and 0·5675 respectively for the ascending and descending sides. Hence, since the load on the ascending side is 12,000 + 8,000 = 20,000 lb., the corresponding rope pull

$$P_a = 20{,}000 \times 0{\cdot}6639 = 13{,}278 \text{ lb.},$$

and, since the load on the descending side is 8,000 lb., the rope pull is

$$P_d = 8{,}000 \times 0{\cdot}5675 = 1{,}540 \text{ lb.}$$

The unbalanced rope pull due to the ascending and descending skips is therefore

$$\begin{aligned} P &= P_a - P_d \\ &= 13{,}278 - 1{,}510 = 8{,}738 \text{ lb.} \end{aligned}$$

This figure, which includes the necessary allowance for rolling friction, multiplied by the drum radius gives the torque due to the loaded and unloaded skips.

Values not given in the table may be found by interpolation. Thus, to find the multiplier for the ascending side of an incline of 52 deg. 15 min. From the table

Multiplier for 53 degrees = 0·8354
" " 52 " = 0·8257
Difference per degree 0·0097

The difference for 15 min., or 0·25 deg., is therefore 0·0097 × 0·25 = 0·0024. Hence the multiplier for 52 deg. 15 min. = 0·8257 + 0·0024 = 0·8281.

Those having to design inclined haulages, and the like, will find the table helpful.

From the same table can also be found the pull to be exerted to haul the rope up the incline. If the length of the incline be L ft. and a rope weighing w lb. per ft. be used; then, when the skip is at the bottom of the incline the weight of the rope $= wL$ lb. and the pull to be exerted $= wL \sin \alpha$.

If the angle of inclination is 38 degrees, the length of shaft 4,500 ft., and the weight of the rope 2·6 lb. per ft., the pull to be exerted is 2·6 × 4,500 × 0·6157 = 7,200 lb. To this pull must be added an allowance for the friction of the guide rollers. The amount to be allowed seldom exceeds 5 per cent. of the weight of the rope in the shaft, and 4 per cent. is a good average value.

Geared Three-Phase Winder for a Shaft of Uniform Slope.

Data are given below of a 10,000 lb. hoist for an inclined shaft. The hoist is usually operated under balanced conditions, but the motor must be sufficiently large to allow of an occasional unbalanced trip being made. It is required to find the rating of the motor, the energy consumption per wind, the overall efficiency, and the amount of cooling water required per hour for the liquid controller.

The data referred to are:—

Nett load	10,000 lb.
Skip	6,000 lb.
Length of shaft	4,000 ft.
Inclination	40 deg. to hor.
Output per hour	100 tons.
Maximum speed	2,000 ft. per min.
Rope	$1\frac{1}{2}$ in. dia.; 3·55 lb. per ft.
Drums.—Twin cylindrical, each 10 ft. dia.;	$\frac{WR^2}{g} = 46{,}250$.
Interval	20 sec.
Sheaves.—16 ft. dia.; $\frac{WR^2}{g} = 8{,}030$ each.	
Motor.—2,000-volt, 50 cycle, 16-pole, three-phase.	
Rolling friction	Angle $3\frac{1}{2}$ deg.
Shaft friction	6% of load + 2 skips.
Rope friction	5 per cent.

Approximate Output of Motor.—A nett load of 10,000 lb. is moved along the slope at a speed of 2,000 ft. per min. Since the angle of inclination is 40 deg. the velocity in a vertical direction is $V \sin \theta = 2{,}000 \times 0{\cdot}643 = 1{,}286$ ft. per minute, and the probable output of the motor is

$$\text{H.P.} = \frac{10{,}000 \times 1{,}286}{33{,}000} \times 2{\cdot}2 = 860$$

Sub-division of Cycle.—To obtain an output of 100 tons per hour there must be 100 × 2,240 ÷ 10,000 = 22·4 trips per hour, calling this 23, to have a little margin on the right side, the duration of the trip is found to be 3,600 ÷ 23 = 157 sec.

The corresponding winding time, allowing an interval of 20 sec., is 137 sec., and the equivalent full-speed valve, which is equal to the length of the shaft divided by the maximum winding speed, is 4,000 ÷ (2,000/60) = 120 sec. Now the time available for acceleration and retardation is, obviously, equal to twice the difference between the actual winding time and the equivalent full-speed time because the average speed during acceleration and retardation is half the maximum speed. Hence, time available for starting and stopping = 2(137 − 120) = 34 sec. Of this time, 14 sec. are allowed for starting and 20 sec. for stopping. Since the nett winding time is 137 sec., it follows that the duration of the constant-speed period is 103 sec.

Distances Moved Through.—During acceleration the skips are moved through a distance of $\frac{1}{2}$ (14 × 100 ÷ 3) = 233·3 ft. At constant-speed the distance moved through is 103 × 100 ÷ 3 = 3,433·3 ft., and during retardation the distance travelled = $\frac{1}{2}$ (20 × 100 ÷ 3) = 333·3 ft. The total distance of 4,000 ft. agrees with the depth of the shaft.

Static Rope Pull.—On the ascending side the loaded skip gives rise to a constant rope-pull that can be determined without difficulty from Table VII.

The load of 10,000 lb. is hoisted, in a skip weighing 6,000 lb., up an incline of 40 deg. From the table it will be seen that for this angle the multiplier for finding the rope pull on the ascending side is 0·6897, hence rope pull

$$P_a = 16{,}000 \times 0{\cdot}6897 = 11{,}035 \text{ lb.}$$

The multiplier for the descending side is 0·5959, and since the load on the descending side = 6,000 lb., the corresponding rope pull

$$P_d = 6{,}000 \times 0{\cdot}5959 = 3{,}575 \text{ lb.}$$

To overcome the general shaft friction a constant rope-pull is required equal to 6 per cent. of the weight of two skips plus the nett load. This combined weight is (2 × 6,000) + 10,000 = 22,000 lb.; hence

$$\begin{aligned} \text{Rope-pull for overcoming shaft friction} &= 0{\cdot}06 \times 22{,}000 \\ &= 1{,}320 \text{ lb.} \end{aligned}$$

There is a constant length of 4,000 ft. of rope in the shaft, of weight $W = 4{,}000 \times 3{\cdot}55 = 14{,}200$ lb. This gives rise to a total reaction, $R = W \cos \theta$ against the guide rollers, where θ is the angle of inclination of the shaft to the horizontal. The reaction, therefore, is 14,200 × 0·766 = 10,870 lb., and, assuming that the pull to overcome friction is 5 per cent. of this,

$$\begin{aligned} \text{Rope-pull for overcoming rope friction} &= 0{\cdot}05 \times 10{,}870 \\ &= 544 \text{ lb.} \end{aligned}$$

Collecting the above figures, we find that throughout the wind there is a constant pull, at the drum radius, of 11,035 − 3,375 + 1,320 + 544 = 9,524 lb., and, since the drum radius is 5 ft., the corresponding torque = 9,524 × 5 = 47,620 lb. ft. This torque, plotted to a time base, is represented by the line *ab* in Fig. 8.

The unbalanced pull due to the rope on both sides can be determined by the method that was used for cylindrical-drum winders operating in vertical shafts* by finding the pull at the beginning of the wind. Since at this instant there is an unbalanced length of 4,000 ft. of rope, weighing 14,200 lb., on the ascending side, it follows that the pull in the rope is 14,200 × 0·643 = 9,100 lb. At the end of the wind there is a similar pull in the descending rope. The corresponding torque is 9,100 × 5 = 45,500 lb. ft., and this is marked off above and below the constant torque line *ab* at the beginning and end of the wind respectively in Fig. 8. By making the simple construction shown we get a bent line, *cdef*, to the base line *ox*, which represents the variation of the static torque throughout the wind.

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* The Electrician, August 23, 1918, p. 354.

Acceleration and Retardation.—The masses to be set in motion consist of rotating parts and travelling parts, and the moments of inertia of these have to be reduced to the drum shaft.

Since the maximum winding speed is 2,000 ft. per minute, and the drum diameter 10 ft., it follows that the drum speed = 2,000 ÷ 10π = 64 revs. per min. The theoretical speed of a 16-pole 50-cycle motor is 375 revs. per min., and the full-load running speed is about 365 revs. per min. The gear ratio, therefore, is 365 ÷ 64 = 5·7 : 1.

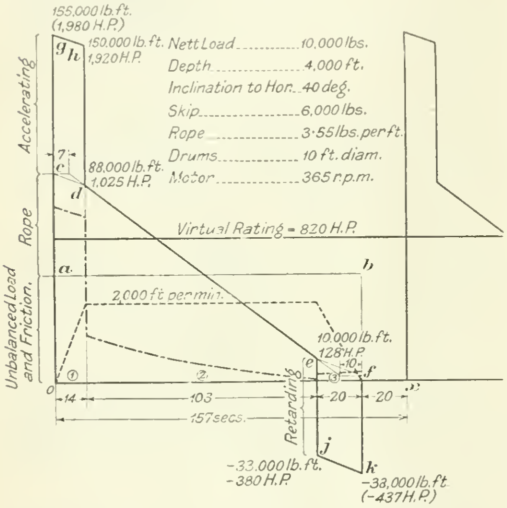

Fig. 8.—Winder Diagrams for a Simple Inclined Shaft.

From Table II. it will be seen that a 900 h.p. 50-cycle motor running at 375 revs. per min. has a $WR^2 \div g$ of 1,144.

The moments of inertia reduced to the drum shaft are :—

Rotating Parts.

Motor = 1,144 × 5·7²	37,200
Drums, clutches and gear wheel	16,250
Sheaves = (2 × 8,000)(10 ÷ 16)²	6,360

Travelling Parts.

Nett load	10,000 lb.	
Two skips = 2 × 6,000	12,000 lb.	
Two ropes = 2 × 4,300* × 3·55 =	30,500 lb.	
	52,500 lb. × 5² ÷ 32·2 =	40,800
	Total	130,610

The maximum speed of 64 ÷ 60 revs. per sec., or 6·67 radians per sec., is reached in 14 seconds from the commencement of the wind, and the acceleration = 6·67 ÷ 14 = 0·477 radian per sec. per sec. Hence

$$\begin{aligned}\text{Accelerating moment} &= 130{,}610 \times 0{\cdot}477\\ &= 62{,}300 \text{ lb.-ft.}\end{aligned}$$

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* Includes allowance for dead turns, &c.

Since retardation takes 20 seconds, the retardation = 6·67 ÷ 20 = 0·334 radians per sec. per sec., and

$$\begin{aligned}\text{Retarding moment} &= 130{,}610 \times 0{\cdot}334\\ &= 43{,}500 \text{ lb.-ft.}\end{aligned}$$

The accelerating moment is added to the static moment line *cd*, giving the line *gh* in Fig. 8. Similarly, the retarding moment combined with the static moment line *ej* gives the line *jk*, and the curve *ghdejk* represents the variation of torque at the drum shaft at every instant throughout the wind.

Motor Rating.—For machine-cut herringbone gears very high efficiencies can be assumed, but the author takes 95 per cent., this figure including an allowance for bearing friction. Knowing the torque on the drum shaft, and the drum speed, the horse power output of the motor can be found.

Thus, when the torque is positive,

$$\begin{aligned}\text{H.P.} &= \frac{\text{Torque} \times 2\pi n}{33{,}000} \div 0{\cdot}95\\ &= 0{\cdot}0128 \times \text{torque}.\end{aligned}$$

and, when the torque is negative

$$\begin{aligned}\text{H.P.} &= \frac{\text{Torque} \times 2\pi n}{33{,}000} \times 0{\cdot}95\\ &= 0{\cdot}0115 \times \text{torque}.\end{aligned}$$

The corresponding horse-power values have been entered on the torque curve in Fig. 8, and from these the rating is determined as shown below.

The heating diagram, found by squaring the ordinates of the power diagram and shown by a chain-dotted line in Fig. 8, has an area of

$$\begin{array}{lr}(1{,}980^2 + 1{,}920^2) \times 14 \div 2 & = 39{\cdot}25 \times 10^6\\ \{1{,}025^2 + 128^2 + (1{,}025 \times 128)\} \times 103 \div 3 & = 41{\cdot}14 \times 10^6\\ \{(-380)^2 + (-437)^2\} \times 20 \div 2 & = 3{\cdot}35 \times 10^6\\ \hline \text{Total} & 83{\cdot}74 \times 10^6\end{array}$$

and

$$\begin{aligned}\text{Equiv. full-speed value of cycle} &= 0{\cdot}5(14+20) + 103 + 0{\cdot}25(20)\\ &= 125 \text{ sec.}\end{aligned}$$

Hence

$$\begin{aligned}\text{Virtual rating} &= \sqrt{(83{\cdot}74 \times 10^6) \div 125}\\ &= 820 \text{ H.P.}\end{aligned}$$

Although a motor of this size is amply large enough from the heating standpoint, the machine is on the small side as regards overload capacity as the peak runs up to 1,980 h.p. when working to the normal cycle. It is advisable to make the ratio of maximum output to virtual output not greater than two, and in the case under discussion this means a motor having a virtual output of 1,000 h.p.

(*To be continued.*)

Power Factor Correction.

The "Canadian Electrial News" states: For the purpose of power factor improvement, the Hydro-Electric Power Commission of Ontario have recently installed at their Toronto Terminal Station, two 4,000-k.v.a. synchronous condensers each equipped with its own exciter driven by a belt from the shaft of the condenser. It is found that the power-factor of the Toronto Station load is raised, by the use of these condensers, from 76·4 to 86·0 per cent. The effect is more noticeable if the wattless factor be considered, for then it is found that this factor suffers a 21 per cent. reduction. For a given kilowatt load on the Toronto Station such an improvement in power-factor reduced considerably the line losses between Dundas and Toronto, and to a lesser degree the losses on the lines from Niagara Falls transformer station to Dundas. These condensers are connected to the 13,200-volt bus-bar at the Toronto station, and, as a result, any improvement in the power-factor of this bus-bar means a reduction in the kilovolt-ampere load carried by the step-down transformers between the 110,000-volt line and the bus-bar. In other words, the total kilowatt capacity of the station is increased about 12 per cent. In addition to increasing the capacity of the station the condensers very much improve the voltage regulation at the Toronto end of the transmission line.

The Poulsen System of Radio-telegraphy.*

By G. PESSION.

The subject matter is divided into five sections, headed: General, Technical Production of the Arc, Matters relating to the Production of the Poulsen Arc, Efficiency of the Arc, and Arc and Spark.

GENERAL.

The arc is produced by a continuous current, a circuit containing inductance and capacity being placed in parallel with it. The characteristics of the Poulsen arc are: The anode which consists of copper and is water-cooled internally, the magnetic field at right angles to the arc, and the atmosphere of hydrogen or some hydrocarbon in which the arc exists. As the condenser charges up, the main current, by reason of an inductance, cannot vary rapidly, so that the current in the arc decreases, and the arc P.D. therefore rises. When the condenser discharges, the current is added to that in the arc, where P.D. therefore falls. The alternating current is thus maintained. Thus in the arc there are two currents: the main continuous current and the alternating current, due to the parallel oscillatory circuit.

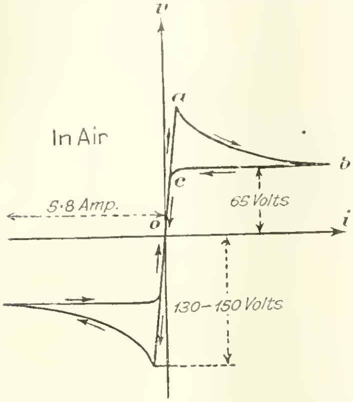

FIG. 1.

The variation in resistance of the arc with change in current may be obtained from statical measurements. These show that the rate of change is much greater for a copper-carbon arc in hydrogen, than for carbon-carbon in air as may be seen from Fig. 2. This rapid change is the condition favourable to the production of oscillations. During oscillations the temperature of the arc does not depend merely on the instantaneous value of the current. The characteristics for the two cases are given in Fig. 2.

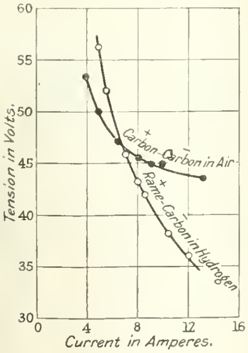

FIG. 2.

W. Poulsen found that for the production of oscillations of the proper frequency for radiotelegraphy, the de-ionisation due to recombination and absorption of the ions was not sufficiently rapid. To increase the rate of de-ionisation he employed the anode of copper, efficiently cooled, the atmosphere of hydrogen on account of the great mobility of the ions, the magnetic field to displace them transversely, and also caused the carbon kathode to rotate upon its own axis.

There are three types of oscillation possible. (*a*) The first type is that in which the amplitude of the oscillating current is less than the value of the main continuous current (Fig. 4). I_0 is the main current and i the oscillatory current. It will be seen that the current in the arc is never zero.

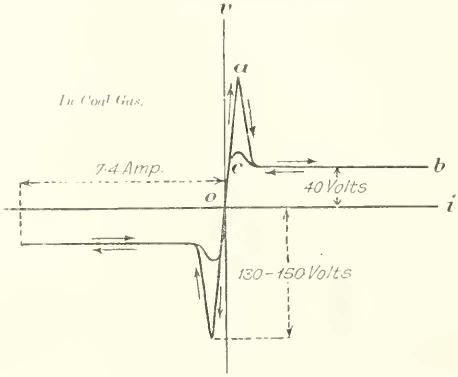

FIG. 3.

(*b*) In the second type the amplitude of the oscillatory current is greater than the value of the main current (Fig. 5), so that the arc is extinguished once in each cycle for a greater or less time according to the constants of the two circuits. V_a is the arc P.D. and v the condenser P.D.

(*c*) In the third type the current in the arc is reversed once per cycle (Fig. 6), in which case a true succession of damped oscillations occurs.

It is found in practice that the Poulsen arc is most satisfactory when it satisfies the condition that the amplitude of the oscillatory current is equal to the value of the main current, so that it occupies the limiting condition between the first and second types. In this case, if I_A *eff.* is the virtual current of the oscillation,

$$I_0 = \sqrt{2}\, I_A \, eff.$$

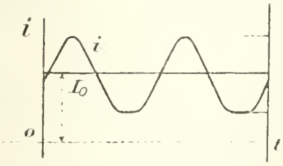

FIG. 4.

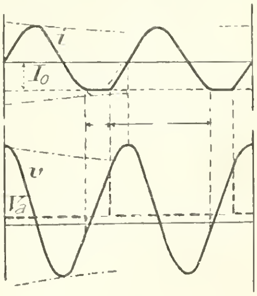

FIG. 5.

An arc fulfilling this condition has been called by Pedersen the "normal Poulsen arc." Such arcs have in general

$$I_A \, eff. > 10 \text{ amp.} \quad \lambda > 1{,}000 m. \quad \rho = \sqrt{\frac{L}{C}} \geq 50\omega.$$

In a Poulsen arc with suitable magnetic field and constant voltage, if the distance between the electrodes be gradually increased, the oscillations at the beginning are of the first type and somewhat unstable. As the length of arc increases the efficiency increases, reaching a maximum when the limiting condition between types 1 and 2 is attained. With further length, type 2 is produced and the power and efficiency fall and eventually the arc is extinguished. The arc currents and oscillatory currents and efficiencies are given in Fig. 7 for increasing length of arc. With the first type of oscillation the frequency is given practically by the relation $T=2\pi\sqrt{LC}$, the constants referring to the oscillatory circuit.

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* Abstract of a Paper in "L'Elettrotecnica," It is published separately by the R. Accademia Navale Livorno and forms No. 5 in a series of pamphlets on different subjects relating to radiotelegraphy.

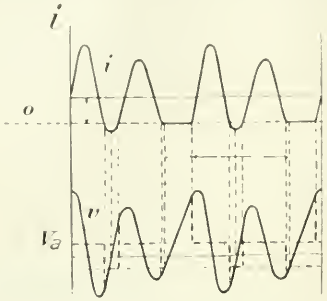

Fig. 6.

Hence a test for the production of oscillations of the proper Poulsen type lies in the facts that frequency is given by $T=2\pi\sqrt{LC}$ and that the ratio of the virtual current to the main current is $1/\sqrt{2}$. When these conditions are fulfilled the arc is in the best condition for efficient working.

Technical Production of the Arc.

The arc is situated in a double-walled bronze case, water circulating between the walls. The cover is provided with a safety valve, in case of explosion due to enclosed air. Alcohol may be used to provide the hydro-carbons, but hydrogen or coal gas is preferred. A small motor produces rotation of the carbon kathode. The circulating water traverses the copper anode, the case, the kathode carrier and the cover successively. Great care is taken with all insulation, keeping in view the high temperature to which it will be subjected.

The scheme of connections is seen in Fig. 8. It will be seen that the main current traverses the electromagnets MM used for displacing the arc. KK are choking coils of three or four times the value of that in the aerial I, and the resistance R is to keep down the current at the moment of striking the arc; it is removed gradually as the arc is lengthened.

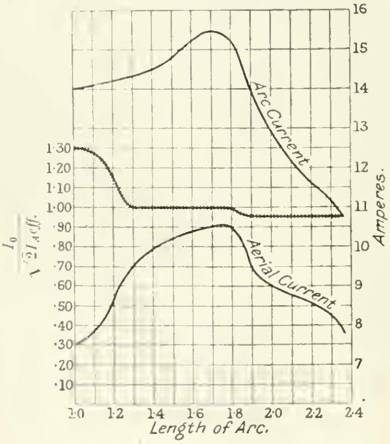

Fig. 7.

For the purpose of making signals, two methods are used: (*a*) Part of the inductance in the aerial is short-circuited by means of a key, which produces a slight alteration in wave-length. (*b*) An internal circuit is substituted for the aerial during the spaces. The latter method is preferable, as although it is more complicated, it avoids the emission of two different waves from the station and the disturbance they might produce.

The design of the electromagnets and of the cooling arrangements has been successfully accomplished, for the use of several hundreds of kilowatts. The limiting difficulty is that of constructing an aerial which will support sufficient current without reaching potentials which render the question of insulation difficult.

Matters Relating to the Production of the Poulsen Arc.

Owing to the complexity of the conditions it is only possible to obtain information respecting the relation of the oscillations to the arc by collecting many data and representing them by families of curves.

The current in the antenna of a normal Poulsen arc is, to a close approximation sinusoidal. Oscillograms of the current (Fig. 9) show this fact, and also that the current is of the limiting form between the first and second type. Further, for large arcs, several cycles occur without the arc being quenched. Fig. 9, due to Blondel, gives the current above and the P.D. for the arc below for a low-frequency oscillation. It shows that there is a sudden rise in P.D at the arc, at the moment that its current is zero. This rise in P.D. was also found by Pedersen using a Gehrcke tube (Fig. 10). The rise occurs when the arc is extinguished and the P.D. falls again rapidly when the arc is re-established. Also Fig. 10 shows that as the arc is lengthened the oscillation passes from the first to the second type.

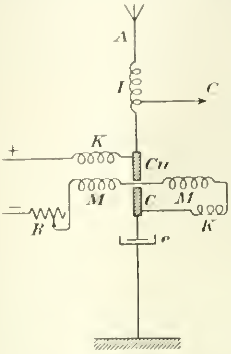

Fig. 8.

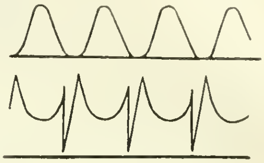

Fig. 9.

Figs. 11, 12 and 13 have been obtained by Pedersen, R in Fig. 10 being a resistance in series with the oscillating circuit. He concludes that the magnetic field should increase with increase of resistance of the oscillatory circuit, should also increase with the density of the gas, the current, and the constant ρ, but should diminish as the wave-length increases. Fig. 13, which refers to one particular arc, shows that the magnetic field is related to the wave-length according to the equation

$$(H+400)\lambda=5{,}000 \text{ gauss km.}$$

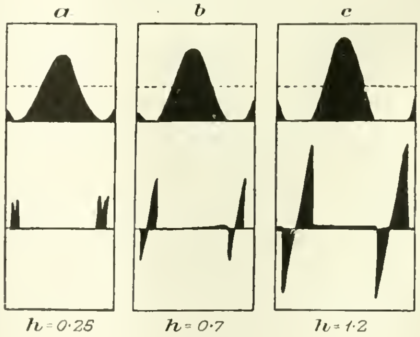

Fig. 10.

Great difficulty occurs in obtaining the intense field necessary to secure the necessary energy with small wave-lengths in an aerial of small capacity. It is clear that there are advantages in diminishing the resistance of the circuit, the constant ρ, and the density of the gas. In practice the conditions are not quite the same as in the above experiments, where the magnets were separately excited, for the coils of the magnets are in series with the arc. The regulation is effected by lengthening the arc until the maximum current is obtained in the antenna.

If the variations of the field are not great with respect to the best value, the arc tends to become stable for a greater distance between electrodes, the smaller the field, and if this diminution is not excessive it reaches with various wave-lengths the P.D. which gives the same current, and hence the same efficiency. With great falling-off in the field, the P.D. of the arc rapidly diminishes; if the field is too strong the arc becomes unstable. It is best to have a small distance between the electrodes for each particular P.D. and apply the field which allows the arc to be stable at that distance.

Nassinth has shown that the frequency attainable with the Poulsen arc is

$$n=\frac{1}{2\pi}\sqrt{\frac{1}{LC}-\frac{l^2k^2}{4L^2I^2_0C}}$$

where l is the length of arc; which shows the advantage of a short arc.

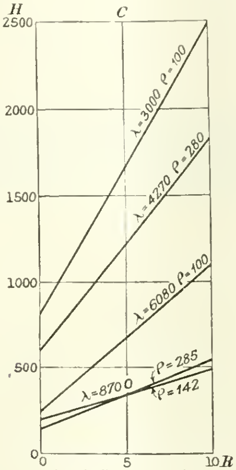

Fig. 11.

With the well-regulated arcs used in practice the variation in frequency on diminishing the length of arc from the best length is inappreciable. Only on lengthening it considerably from the best length is there any sensible variation in wave-length.

In an arc where

$$I=15A \text{ and } L=1378\mu\text{-}h,\ C=0{\cdot}0025\mu\text{-}f,$$

a variation of the distance between electrodes from 1·4 mm. to 1·8 mm. caused the wave-length to change from 3,485 metres to 3,490 metres, and for 2·21 mm. the wave-length reached 3,580 metres. At this last length the arc was unstable and on the point of being extinguished. Similar results all go to show that with intense current and well-proportioned constants of the circuit, the alteration in frequency due to change in length of arc is negligible.

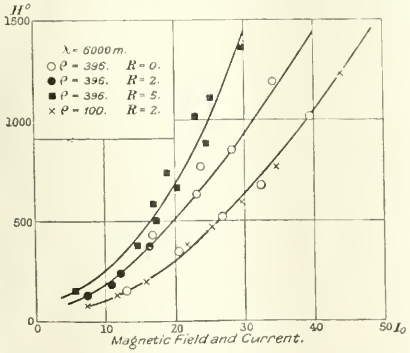

Fig. 12.

It is of the greatest importance that there shall be no air or oxygen present. In a certain case where the gas contained 0·4 per cent. of oxygen, a wave-length of 7,000 was obtained with an antenna P.D. of 800 to 850 volts, according to the condition of the atmosphere, and a current of 105 amperes. In consequence of the infiltration of air it was found impossible to obtain this current without increasing the P.D. to 1,100 volts. If the oxygen exceeds 1·1 per cent. by volume of the gas the efficiency and power attainable drop rapidly. Various hydro-carbons have been tried. For small arcs the ordinary methylated spirit of commerce produces good results, giving a good efficiency with regular consumption of carbon without producing carbonaceous deposits, which render frequent cleaning necessary. A slight addition of benzine or petrol increase the efficiency and lessen the consumption of carbon. With large arcs (100 kw.) coal-gas gives the best result, but has the disadvantage that the deposit of carbon within the case renders frequent cleaning necessary; in fact, a radiotelegraphic station using it must have two arcs which are used alternately. The best results are obtained with hydrogen, but its cost of production is great and its explosive power renders it difficult to use. Methane has the advantages of hydrogen and is easy to produce.

Efficiency of the Arc.

The efficiency of the arc η is defined by the relation

$$\eta EI_0 = RI_A^2,$$

where I_0 is the main continuous current at voltage E, R the resistance of and I_A the current in the oscillatory circuit. It has been seen that for the normal Poulsen arc $I_A^2=\frac{I_0^2}{2}$.

$$\therefore \qquad \eta=\frac{1}{2}\cdot\frac{RI_0}{E}.$$

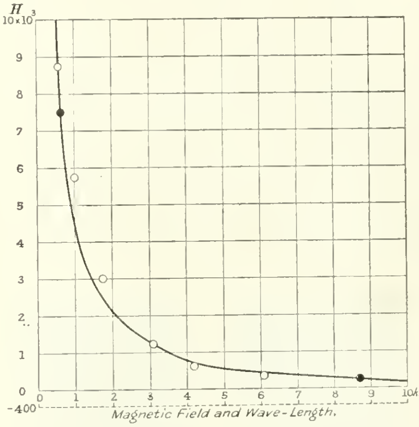

Fig. 13.

Owing to the difficulty of measuring the power by means of a wattmeter it is necessary to find the resistance of the antenna, an uncertain quantity which is a function of the current. η approximates to the value 0·5 and in a given case of a 3 kw. plant,

Capacity of aerial	0·003 μf.
Length of wave	3,040 metres.
Voltage of generator	180 volts.
Arc P.D.	160 volts.
Main current	17·5 amperes.
Antenna current	12·4 amperes.
Resistance of antenna	7·5 ohms.
Power in arc	2,800 watts.
Power at antenna	1,160 watts.

$$\eta=0{\cdot}4.$$

Arc and Spark.

It is of interest to make a practical comparison of the Poulsen arc and the spark radiotelegraphy, from the points of view of the emission, propagation and reception of the waves. As regards propagation, the advantage of the continuous wave produced by the arc, over the damped wave of the spark is not very clear. It is when the reception of the waves is considered that the advantage is most marked. In using an amplifier and telephone, a high-pitched penetrating note is produced, which is much more distinguishable from atmospheric disturbances than the sound produced in the case of the damped spark. Further, it is possible to receive with an aerial much smaller than that necessary with the spark. Thus the advantage of the arc lies in the facts that it is possible to produce long waves with good efficiency, and to use sensitive receivers, with great amplification, in spite of atmospheric disturbances.

Standardisation Rules for Electrical Machinery*

By A. R. Everest.

A machine when given the "British Standard" continuous rating is rated for the highest load which it can carry for an unlimited period without exceeding the limits of temperature-rise allowed by the Rules. There has been much misconception regarding the feasibility of allowing a machine so rated to take overloads in excess of its rating. The I.E.C. Rules are now so worded as to show clearly that the rating is a test rating, and as regards service conditions, the only limitation is that the machine shall not be subjected to any loads which cause it to acquire a temperature-rise higher than that allowed under the test condition. But undoubtedly there are dangers associated with excessive overloads. Against these dangers there appears to be at present no safeguard in the British Rules, which impose no restriction on overload except in terms of temperature-rise. It appears desirable, therefore, that there should be an agreed limit to the magnitude of the sustained overload to which a standard machine may be subjected, and that limits to the magnitude of both the sustained and momentary overloads should be recognised. For this purpose it has been suggested that a sustained overload of 25 per cent. for half an hour should be allowed for all motors not smaller than 5 h.p., subject to the rule that the standard temperature-rise must not be exceeded.

Cooling Conditions.

The "British Standard" Rating is suitable for use in connection with cooling air of temperature not exceeding 40 C. as a maximum. It is now proposed to establish a tropical rating with an appropriate higher limit to the maximum temperature of cooling air. Whether this shall be 50 C. (120 F.), or 55 C. (131 F.), is not yet decided. No special modifications are necessary for machines working indoors in cold countries. Those unusual cases in which a machine will operate under abnormally low cooling conditions should be regarded as special, and designs made accordingly. The general rule for all such special designs would be, that when tested under rated load the temperature-rise should be such that when added to the temperature of the cooling conditions contemplated, the highest temperature obtained must not exceed the limits of total temperature indicated in the Rules.

Measurements of Temperature-Rise.

The requirements of the earlier edition of the rules were that temperature-rise measurements of field coils and similar windings should always be by resistance method. This has been regarded as impracticable on small machines produced in large numbers. These measurements may now be made by thermometer alone, provided that readings so obtained are consistent with the limits assigned to the resistance method, as shown by complete tests taken on a few typical machines.

There is a strong feeling among engineers that for turbo-alternators and for other large machines the temperature-rise should be determined from measurements made by embedded temperature detectors. The I.E.C. has not as yet formulated definite rules, but they have submitted for the consideration of the British and other National Committees a proposal on the following lines: "That for the acceptance tests of large rotating machines the temperature should be measured by the embedded temperature detector method for parts where this method would be applicable." This method would be applied only to windings in slots on the stationary part of a machine, the embedded temperature detectors being placed between coil and adjacent slot wall, and between coil and coil in the slot, in each case outside the coil insulation. This method of temperature measurement should be employed for the stationary windings of machines meeting the foregoing conditions when such machines are wound for more than 5,000 volts, or are rated for an output exceeding 750 k.v.a., or if the stator cores exceed 20 in. axial length. The proposal contemplates that the method also may be applied to the windings of large transformers, provided this is specified in the contract.

DISCUSSION.

Dr. M. Kahn said the present rules did not contain any standard tests to ascertain whether electrical machinery complied with guarantees. The proposed extension of the rules for temperature measurements on large generators by thermo couples or resistance coils was a step in the right direction. In large turbo-alternators, where the eddy current loss in the stator conductor was reduced by suitable means the temperature-rise of the conductors was indicated closely by this method although the detector was not in direct contact with the copper. The starting torque required and the starting current which could be allowed to self starting synchronous motors were omitted in the lists of information required with enquiries for such machinery. It was not mentioned that the pressure induced in the rotor windings entirely depended on the pressure applied to the stator terminals when starting. A rough division was made between two classes of motors of exciter pressures above and below 250 volts. As the exciter pressure largely influenced the voltage to which the rotor windings were subjected at starting a further grading of test pressures seemed appropriate.

Mr. H. W. Taylor said in the rating of large machinery it would be the custom in future to specify the actual inlet temperature at which the machines were expected to operate, and under these conditions the maximum internal temperatures should not exceed those specified by the International Standardisation Rules. With regard to the use of turbo-generators in tropical climates the employment of a wet air filter helped considerably in reducing the initial temperature at which the air entered the machine.

Mr. R. Orsettich said the standard frequency was stated to be 50 cycles, in view of the fact that very large industrial districts in this country and elsewhere were supplied with power at 25 cycles the adoption of 25 cycles as a second standard frequency should be considered. The standard pressures for continuous current motors did not include 550 volts, but as a large number of traction motors were required this pressure should also be included. The short-time rating mentioned had given rise to misunderstanding, as there was no explanation as to how this rating could be used in practice, and the time which must elapse between two subsequent periods of work, each of which was equal to the short time rating, was left open. It was proposed that the maximum temperature rise allowable under tropical conditions should be 15 C. less than the rise allowed for normal conditions. This appeared to be preferable to 10 C., in view of the uncertainty of the ambient temperature. The output of the generator used for the pressure test should be given, as the absence of any ruling might give rise to abnormal requirements by inspectors. The items specified to be given on every name-plate were so numerous that it would be difficult to accommodate them on a plate of reasonable size.

Mr. A. T. Bartlett was glad to see there was no mention of the pernicious "flashing" test. Tolerance should be allowed in temperature rises. An international specification was an assistance to international trade. In Australia, where in pre-war days Continental machines were competing with British machines, a Continental motor was frequently purchased because of its lower price, owing to all motors of a given horse power being considered as having the same output. The purchaser was not aware that the Continental motor had only 0·85 or even less output of the British motor.

Mr. N. Joseph suggested a table of efficiencies for varying sizes of continuous and alternating current machines, and laid stress on the necessity for the name-plate showing the rotor current of slip ring motors, and the field current of all continuous current machines.

Mr. R. G. Jakeman said it was not quite clear why commutators and slip rings were only allowed a maximum temperature of 90 C., while the maximum permissible temperature for mica was 125 C. The maximum actual temperature of field coils was 105 C., and the maximum temperature by resistance 95 C. Did this allow for the deepest coils met with in practice?

Mr. A. R. Everest (in reply) said: Embedded temperature detectors were now in use for research purposes, but it was doubtful whether they ought ever to be admitted for the commercial tests. They were undoubtedly of great practical use in the case of large turbo-generators, particularly in indicating any tendency to change of temperature due to clogging of the ventilating ducts. In tropical countries little reduction in the temperature of the cooling air would result from the use of the wet filter owing to high saturation. It was obviously necessary that for any particular service a short time rating should be selected which gave the same temperature-rise as the intermittent load in service. In the earlier Rules temperature tests for machines with continuous rating were continued until the rate of increase of temperature did not exceed 1 per hour. But the length of time required to attain this condition, and the amount of difference still existing from the ultimate constant temperature condition, both depended upon the thermal time constant of the machine. The present Rule assumed that the shape of the temperature curve would be plotted and its ultimate value thereby predicted. Any testing equipment which was too small to maintain the test pressure at its full value for one minute when applied to the apparatus under test was insufficient for the purpose. Nothing was gained by specifying a larger minimum capacity. The use of a temperature tolerance always carried with it a "resultant maximum." The temperature limits given in the International Rules were expressly defined as "maximum values"; if a tolerance was to be employed it must be based on such lower value that adding it would not cause the "maximum" to be exceeded. The temperature of commutator was lower than of mica insulation owing to the effect of the temperature of the commutator upon the insulation of the adjacent windings, &c.

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* An Account of the Opening Remarks and Discussion at a Meeting of the South Midland Centre of the Institution of Electrical Engineers.

Positive Rays.

(Concluded from page 320.)

In abstracting the last three of Sir J. J. Thomson's Royal Institution lectures on "Positive Rays" we shall, for brevity sake, not quite adhere to his sequence. The analysis, he said, had brought out much more than he had expected. It distinguished between atoms and molecules, between positively and negatively charged elements, between elementary and compound particles of the same mass; it proved the existence of particles apparently of half the mean atomic weight of C, N, O, &c., due to the particles carrying two charges; it showed that the splitting up goes much further than anticipated, and as it separated every constituent, no matter what constituents be present, it allowed of far more delicate determinations of atomic weight than the chemical balance, for which the material had to be chemically pure, whilst purification was unnecessary for positive-ray analysis. When chloroform was split up, he found not only Cl_1, Cl_2, H, but also ClH_2, ClH_4, ClH_5, in addition to CO, CO_2, CN (due to impurities), all positive, and, further, Cl and O on the negative side. Fig. 1 illustrates some of the results of the already mentioned focus-method of Aston. The five bands seen in the third strip correspond, from left to right, to particles 20/2, 22/2 (both neon), C12, CH13, $CH_2$14, $CH_3$15, $CH_4$16, the latter four being so regularly spaced as to serve as a scale. Investigating chlorine, Aston found lines 35, 37, 39, but no line corresponding to 35·5, the atomic weight accepted by chemists. Now, 37 and 39 might be hydrides ClH_2 and ClH_4, or be isotopes; the elementary character of chlorine had often been questioned. But lines 37 and 39 were associated with lines 37/2 and 39/2, as if due to particles carrying double charges; that would speak for their elementary character. Other lines indicated hydrides. The criterion was that the beaks were only found in the case of atoms of elements (with possibly two exceptions), not in the case of elementary molecules or compounds. Hence, chlorine seemed really to have isotopes, and the chlorine 35·5 of the chemist to be only a mixture of isotopes. If chlorine were 35, the most striking exception to Prout's law, that all atomic weights were integers, would be accounted for.

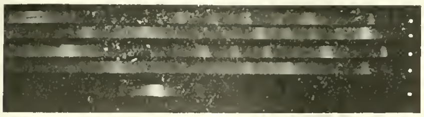

Fig. 1.

The beak was very striking in Fig. 2, illustrating the discharge through very pure oxygen. In this and the other photographs (taken by the lecturer's own method) most of the parabolas do not begin at the origin but on a normal ordinate at some distance from the origin. The lower parabola of Fig. 2 was the oxygen molecule; the upper, the atom, showed a beak extending half-way across that distance; the faint line further above was O/2. The beak indicated that the particle carried double the normal kinetic energy and was hence less deflected. If the particle started with two charges and retained both while passing through the kathode tube and the electric and magnetic fields, its deflection would also be doubled, and the parabola would begin at the normal ordinate; if it lost one of the charges between the kathode and the fields, the particle would, owing to its greater kinetic energy, be pushed back less than the normal distance, and would show the beak. In Fig. 3, discharge through CO, the ordinate was again very distinct, but the two central lines due to the mercury atom were continued to the origin, and these lines, as well as the others, showed bright and dark spots; in other photographs—Sir Joseph had taken more than 2,000—the lines were beady. There, as Stark had shown, the double charges and the Doppler effect* came in. If oxygen particles with double and single charges were present, the former would acquire higher speeds and their spectrum lines would be more shifted. Stark found that particles with double charges gave rise to Rydberg's "sharp" series of lines, and particles with single charges to the "diffused" series. An atom line of oxygen could thus arise in two ways. The molecule might be split up into atoms before entering the kathode tube, or after entering it; in the latter case the energy would be divided between the two components. When the particle was a compound like CO (C = 12, O = 16), the energy would not simply be halved, but the components would be 12/28 and 16/28, and beads would show at points corresponding to those energy portions. Thus, lines starting at some distance back from the normal ordinate belonged to broken-up compounds. From the ray analysis, helium—though considered monatomic and not inclined to form any compounds at all—seemed to be able in rare cases to appear as He_2 and to break up subsequently; and a mercury molecule, Hg_2, seemed likewise to occur. When lines appeared on the negative side of the photograph (as in Fig. 2) (as a rule they were only on the positive side), the particles must have acquired negative charges, after passing through the kathode, by collating with molecules. That had been observed with negative elements like oxygen and chlorine, further with OH, and also with CH (decomposition of hexane C_6H_6). A long parabola meant that there was a wide range in the energy of the particles, a short parabola that they were practically all endowed with the same energy. In the discharge tube the fall of potential was mainly in the dark space between the kathode and the negative glow. Particles split up on the anode side of the glow would pass, with the maximum possible energy, right through the kathode tube, and would concentrate in the head of the parabola. If particles formed close to the kathode, they were not long in the field, and would be carried to the end of the parabola. From the length of the parabola we could hence draw conclusions as to the space in which the particle originated as such, by splitting up or by uniting.

Passing to the properties of positive rays, Sir Joseph said that the positive particles, travelling at about 2,000 miles per second (hydrogen $2{\cdot}8 \times 10^8$ cm.) were, with respect to energy, intermediate between gas molecules and the ten times faster α-particles of radium (helium atoms). Goldsmith had found that they could penetrate mica sheets 0·0005 mm. thick. H. R. von Traubenberg placed pure gold foil of 3×10^{-6} c.m. (not extravagantly thin) over the phosphorescent screen, and found that the hydrogen atom and molecule and atoms of O (or N ?) seemed to be able to penetrate, and to lose their charge while penetrating. It was well known that metal kathodes (not anodes) sputtered when bombarded by positive rays, and that black metallic films settled on the glass near them; cadmium sputtered very readily, aluminium little; glass was coated with metal films, and silver lace was made in this way. The energy required could be calculated from the heat of vaporisation; and it was strange that for cadmium the energy required to liberate a molecule from the metal was equivalent to a potential fall of 1/20 volt only, whilst the sputtering did not set in until 500 volts, 10,000 times as much energy, were applied. That suggested that the atoms were liberated in groups, not singly, somewhat as in Worthington's splash experiments, where a drop of water falling on water raised a water crater round it, which then broke up into spray. The denser the gas in the discharge tube, the greater the sputtering; in argon even aluminium gave dense film deposits. Stark had shown that quartz, mica and other substances were disintegrated by positive rays, and Sir Joseph has used this bombardment and his method for investigating the gases liberated from bombarded minerals and salts. Nine-tenths of this gas was generally hydrogen, together with CO and CO_2. The bombardment of potassium iodide gave (Fig. 4) H lines H_1, H_2, the line 3 (presently to be discussed), various C, N, O lines, H_2O, CO, CO_2, &c. The figure shows the normal ordinate well; a similar variety of lines was observed with zircon and with beryll (Fig. 5). In some of these the helium line 4, and further lines corresponding to atomic weights 3 and 3·5 came out, both generally faint

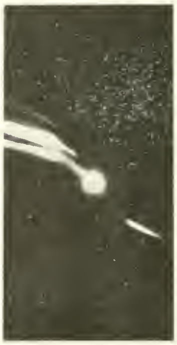

Fig. 2.

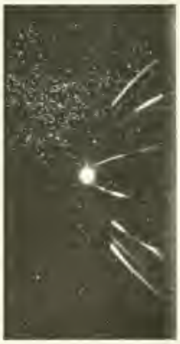

Fig. 3.

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* If the source of vibrations approaches the observer, more vibrations are received per time unit, and the spectrum lines shift to the violet, or the sound pitch is raised. Doppler 1842.

The line 3 seemed in many cases to be associated with hydrogen, though a compound H_3 was unknown and seemed impossible; the line also appeared when phosphonium iodide, PH_4I, was bombarded, in which hydrogen was joined to phosphorus which was trivalent [pentavalent ?]. In Fig. 6 both the 3 and the 3·5 were visible, and also the faint straight traces joining the parabolas to the origin; these traces leading to the line 3 are likewise conspicuous in Fig. 4. Considering the ubiquity of the hydrogen lines on all the plates (even when hydrogen was only present as impurity), it was surprising that the 3 was not more frequent, and that it was faint—*e.g.* when ammonia NH_3 was bombarded. On the other hand, the 3 was persistent with bombardments continued for months, whilst the line 3·5 soon disappeared, as if the respective substance were stored in small quantity only. The 3·5 might be ascribed to a doubly-charged lithium, atomic weight 7: but it was very hard to get even lithium lines with one charge. The 3 and 3·5 almost always occurred together, however, and were strong when a variety of fluorspar, from the cryolite deposits at Ivigtut, Greenland, was bombarded; this fluorspar was distinguished by a strong fluorescence (when the powdered mineral was placed on a hot plate of iron), more marked than in other varieties of fluorspar. The line 3 might sometimes have a different origin, and be the nebulium line, which was otherwise known only in certain stellar nebulæ. In this connection the Doppler effect and Rayleigh's deduction of the nature of a substance from the width of a spectrum line had to be considered. Gas molecules in thermal agitation had not all the same velocity, and the spectrum lines were hence not sharp. Now the velocity was proportional to the square root of the atomic weight, and if we knew the temperature and the velocity we could find the atomic weight. Fabry had applied this method to nebulæ whose spectra showed both the hydrogen and the nebulium lines. The hydrogen gave him the temperature, and the atomic weight of nebulium so deduced was found to be 3.

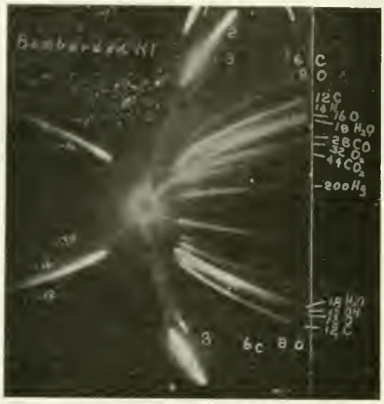


FIG. 4.

Of other obscure lines which Sir Joseph had detected by positive-ray analysis he mentioned 1·6 (faint, but frequent) and 2·4 (frequent in bombarded minerals). He had looked for isotopes of nitrogen 14 (intermediate between C 12 and O 16), but had found none; he suspected nitrogen because the atomic weights of most elements (up to calcium 40, at any rate) were either divisible by 4 or gave the remainder 3; the chief exceptions to this rule were beryllium 9, nitrogen and chlorine. In addition to the cases of possible isotopes already mentioned, Aston had found argon 40 and 36, instead of 39·9; krypton 84, 82, 86, 83, 78, instead of 82·9; xenon (126, 131, 130, 133, 135), instead of 130·2; mercury 202, 204 (197, 200), instead of 200·6; numbers in brackets were uncertain. Large quantities of H_3 Sir Joseph himself had found, together with He_1 in radium emanation from a tube 10 years old: in another radium tube of Mr. Glew, which had only been kept for months, H, H_3 and He were present.

In concluding Sir Joseph outlined some novel important deductions. The study of the effects produced by a moving electron led to the result that the mass of the electron was due to its charge and was distributed throughout the electric field around the electron (not concentrated in it): the amount of the mass per unit volume at any place *P* being proportional to the square of the electric force at *P*. Now the potential energy at *P* was also proportional to the square of the electric force and was equal to the kinetic energy which the mass would possess if moving with the velocity of light. That implied that the potential energy might really be the kinetic energy of the mass distributed throughout the field. If generally all mass, whether of electrons or of atoms, had the same origin and were due to mass diffused through the space surrounding the atom or electron, the distribution of the mass would be determined by the distribution of the lines of force, and further all sorts of energy—kinetic, potential, chemical, thermal, radiant—would be of the same kind and would be the kinetic energy of the mass moving with the velocity of light. A "transformation" of energy would on that view merely be a flow of this mass with the intrinsic kinetic energy from one position of space to another under the direction of the lines of electric force; if we attached reality to the energy, the idea of transformation involved philosophical difficulties. To visualise physical phenomena he would suggest that (1) mass was made up of exceedingly small particles all moving with the velocity of light; (2) that the force exerted on a particle by others or by the electric field was at right angles to the direction in which the particle was moving, so that, though the path might be deflected, the energy remained constant; (3) that the mass of the particles per unit volume was:

$$\frac{1}{8\pi}\left\{\left(f+\frac{hv}{c}-\frac{gw}{c}\right)^2+\left(g+\frac{fw}{c}-\frac{hu}{c}\right)^2+\left(h+\frac{gu}{c}-\frac{fv}{c}\right)\right\},$$

where f, g, h were the component of the force parallel to the x, y, z axes, u, v, w, the velocities of the lines in those directions and c the velocity of light. From this expression the usual equations for the electromagnetic field could be deduced. But why did the mass remain at a spot if moving with the velocity of light? That was because the particles were not travelling continually in one direction, but were rotating round the lines of force, which were themselves anchored at their ends, passing in a steady field (like arcs) from a positively electrified body to a negative one. When the bodies themselves were moving, the lines of force would move too and would be thrown into closed loops which were not anchored, the particles carrying the lines of force with them and tearing away with the velocity of light. Radiation then consisted of the mass-producing stuff travelling with the velocity of light, and it must be accompanied by diminution of mass. This mass-producing stuff was somewhat like the old ether, but not uniformly distributed through space, and radiation carried its own ether with it; there need be no ether where there was no radiation. The stuff would thus combine the functions of matter and ether on the old view. It was the vehicle of radiation, but not the whole of either matter or radiation: the lines of electric force were an essential part of both, forming the skeleton of the structure. If we had two particles in juxtaposition, $+A$ and $-B$, the stuff would be distributed round AB and would tend to flow according to (3) from the weak part of the field to the strong, in our case from the left to A and from the right to B, so that they both gained momentum towards each other and approached each other. The consequences of these views were not contradictory, and compatible with the theory of relativity.

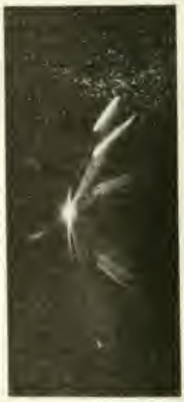


FIG. 5.

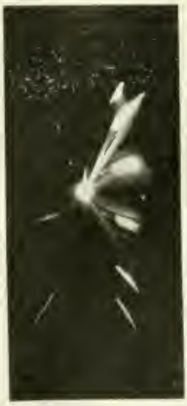


FIG. 6.

Mr. E. Everett was in charge of the demonstrations.

Some Modern Electric Welding Machines.

The use of heating effect of an electric current in the welding of metals is a modern example of the application of physical science to industry. Its development until quite recent times has, however, been slow, owing partly, no doubt, to the conservatism of the manufacturer, and partly because the relatively unskilled labour which was required for carrying out this class of work was cheap, and it therefore was better for the balance sheet to employ it than to use more modern methods. To be quite fair, however, there was a third reason which, like many last reasons, was the best of them all, and that was that there was some reasonable doubt as to whether welds effected by electrical processes were as strong and efficient as those carried out by the older methods. There is now, however, no doubt on this score and it may truly be said that the weld carried out by electrical means has nothing to fear as regards strength and efficiency generally from the weld effected by other methods. Taking everything into consideration, therefore, we have every reason for thinking that the next few years will show an even greater development in this class of work.

Any doubts we may have had on this subject were dispersed at the very interesting demonstration which was recently held at the Bradford works of the A-1 Manufacturing Company, when the possibilities of electric resistance welding for all classes of work were amply demonstrated.

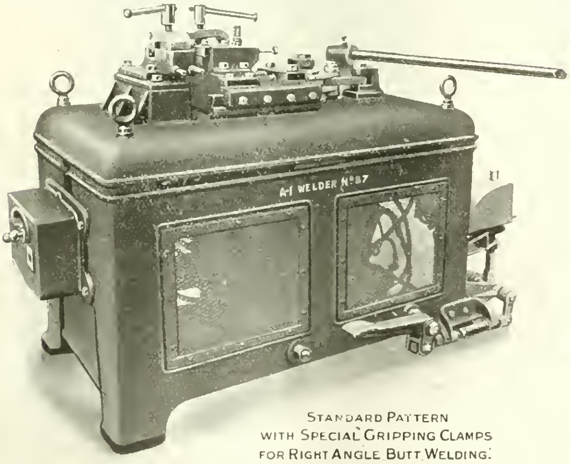


Fig. 1.—View of A-1 Butt Welder.

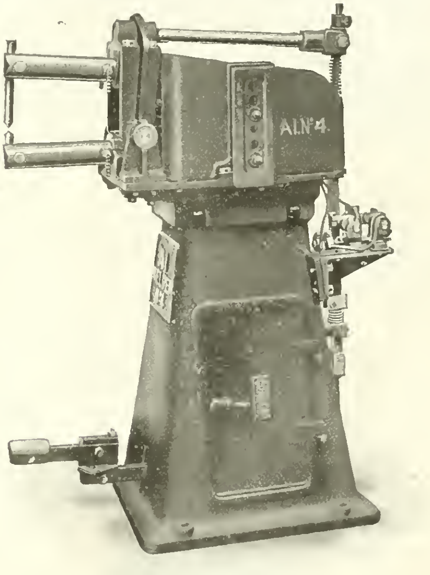


Fig. 2.—One Pattern of A-1 Spot Welder.

The most interesting machine shown was a butt welder which has been specially designed for the welding of tyre sections It is capable of taking work up to 8 sq. in., and has electrical capacity of from 80 kw. to 100 kw. This machine has been designed to join weldable iron and mild steel tyres of sizes within the limits laid down above. We understand that it can be operated by unskilled labour and that after the practice of an hour or two the average person can make a thoroughly satisfactory weld. It is a little difficult to say what the output of the machine is, as the number of welds per minute must depend upon the size, shape and condition of the material and upon the skill of the operator, but it may be stated that on small tyres of 4 in. by $1\frac{1}{2}$ in. mild steel, the time taken per weld is about 20 seconds.

The tyre to be welded is placed on water-cooled copper blocks, being held in position by adjustable grips which are brought down on the tyre and held in position by special cam levers, so that it is gripped on both sides, the joint being half-way between the grips. A hand wheel at the side of the machine allows the distance between the blocks to be adjusted through worm gearing so that the two ends of the tyre to be welded can then be brought into close contact. After the weld has been made and while the metal is still hot further pressure is applied in the same way to make sure that the joint is satisfactorily made.

Electrically the equipment consists of a single phase transformer, which is contained in the base of the welder. This transformer has a series of tappings on the primary side which are led out to a rheostat, thus giving the necessary voltage adjustment on the primary side. Four heating speeds are available by this means, the particular one used depending, of course, on the material which is to be welded, its size and general properties. Connection is made from the secondary side of the transformer to the adjustable copper block by massive copper tapes, the current being very large as it will be gathered when we say the voltage on the secondary side varies from $1\frac{1}{2}$ to 8 volts. The other fixed copper block is in direct connection with the body of the machine, to which the other end of the secondary winding is of course connected. The copper blocks are renewable and are fitted either with grooves or triangular slots, depending on the shape of the material which is to be welded. The electrical circuit is controlled by means of a switch which is operated by two foot levers which pull a quick break switch on or off as required. This switch is locked in the "on" position by a toggle, and the flash on breaking is taken on adjustable brass contacts. A general view of the electrical arrangements of the machine is given in Fig. 1, though the actual illustration is of a smaller type of welder.

Another interesting type of welder made by this Company is the electric seam welder. This is manufactured in various patterns, but particular reference may be made to one which will effect welds from 30 S.W.G. to 3/32 in. in brass, and from 30 S.W.G. to 3/16 in. in mild steel. The welding on this machine can be carried out at considerable speed. For instance, for two thicknesses of 30 S.W.G. sheet a weld speed of $10\frac{1}{2}$ ft. per minute can be obtained. Four-speed cones are fitted on the driving shaft so as to give a good operation speed to suit the range of machine. The actual welding process is extremely simple. The joints to be seam welded having been cleaned by sand blasting or pickling are laid one on top of the other with as little overlap as possible. The copper block on which they rest forms one electrode of the circuit, the other being a revolving copper disc. The edges of the sheet are pinched together by bringing the roller electrode into contact with the edges of the seam and making a preliminary weld. When partial contact has been obtained in this way along the whole length of the seam, the roller electrode is set revolving and brought into contact with the material to be welded. The current is switched on and the metal rapidly reaches welding heat. In this way the whole length of the sheet is travelled. This particular machine is fitted with a number of transformer tappings, so that eight heating speeds are obtained. The top arm carrying the driving arm electrode is hinged at the welding level of the bottom roller, so that a high pressure is obtained on the weld. This hinge, however, does not carry any current. The revolving electrode is water-cooled and the standard bottom arm is also water-cooled. Both electrodes are easily renewable.

These welders can also be fitted with a circular seam welded bottom arm for use in welding the bottom of drums, &c., where there is only a slight depth, whereon to get the bottom roller electrode. The maximum electrical capacity for this machine is 15 kw., and in general the electrical arrangements follow those described above.

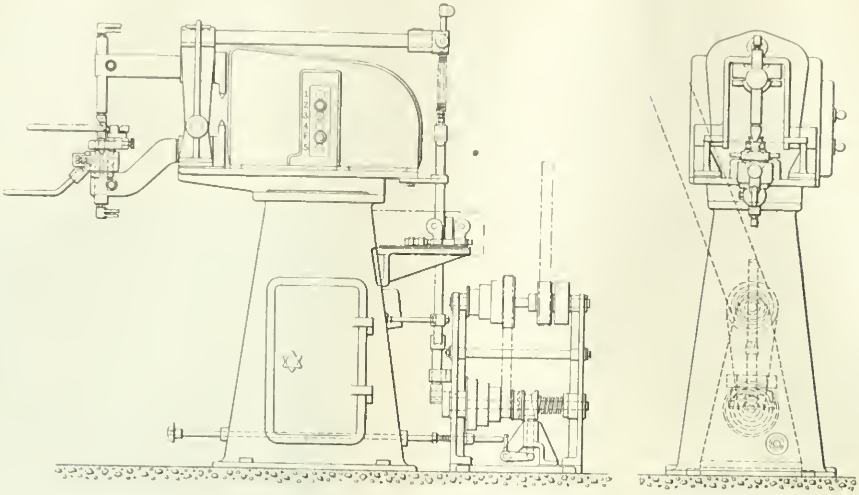


Fig. 3.—Section of A-I Spot Welder.

The Company is also making a speciality of the manufacture of electric spot welders, one of which is shown in Figs. 2 and 3. In these the top arm is gripped to a vertical slide, so that the working pressure is obtained on the weld. This slide is adjustable and of good proportion and is designed to carry the top and bottom arms which are fitted into round sockets so that they can be twisted to almost any angle to get into awkward places. These arms carry hard-drawn copper electrodes of $1\frac{1}{2}$ in. in diameter, which are water cooled and are fitted with taper ends into which renewable tips can be inserted. These tips are conical shaped on the outside with a slight radius on the extreme tip of a diameter equal to the size of the weld required. This machine can be fitted with an automatic device so that when a series of welds have to be made on a plate the current is automatically cut off and the electrode raised as each weld is completed. This is effected by means of a cam on the driving shaft which switches off the current and raises the top electrode arm. The machine can also be operated by means of a foot switch and the electrial arrangements are generally those described above for the butt welders. The machine is made with 9 in. stakes, but stakes of varying lengths and shapes up to a maximum of 36 in. can be supplied. The switch and all other parts are fully guarded, and are rendered as foolproof as it is possible to make them without interfering with the work of the machines. A wide electrical range is obtainable by means of transformer tapping on the primary giving eight heating speeds in all, so that a very fine graduation can be obtained. We are informed that the operator soon learns which speed to use, the choice, of course, depending on the thickness and character of the material being welded.

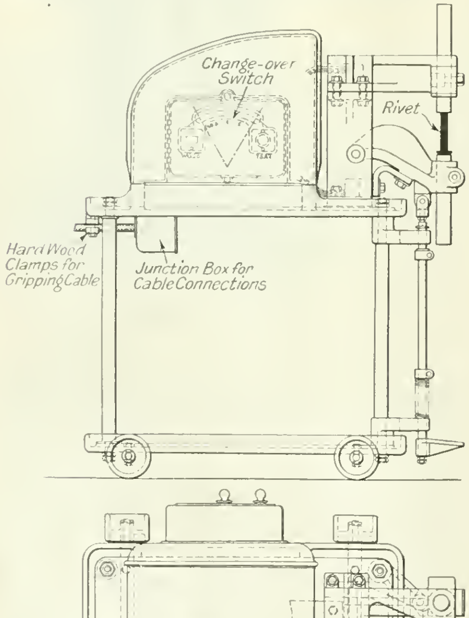

Change-over Switch
Rivet
Hard Wood Clamps for Gripping Cable
Junction Box for Cable Connections

Fig. 4.—Section of New Design of Rivet Heater.

Another interesting equipment is the electric rivet heater shown in Fig. 4. This will heat rivets of mild steel (continuous working) from 5/16 in. to 1 in. diameter by 4 in. long and occasionally by 6 in. long. By placing the standard rivet between the top and bottom electrodes the heating instantly commences, and continues until the rivet is pulled from between these, so losing no time to switch on or off the current. This has the great advantage that no dirt can attach itself to the metal and as the heating is quicker, less scale is formed. The number of heated rivets per minute depends upon the diameter, and of course the smartness of the operator. But it may be stated as an example that 1,000 rivets of 5/16 in. diameter mild steel can easily be heated per hour. The operation of the machine is extremely simple. The operator depresses the foot pedal thus bringing down the bottom electrode places the rivet upon this and withdraws his foot still holding the rivet. By so doing the rivet is pinched between the top and bottom electrodes by a spring. As there is no switch to operate, the rivet immediately commences to heat, and the time taken up in so doing is compensated for by another rivet being ready on one of the other heads. Three heads are provided. The range to which this heater can be adapted is a wide one, eight heats being provided. The machine is easily portable and all the electrical parts are well guarded so as to render it fool-proof.

We have to thank the A-1 Manufacturing Company for the loan of the photographs and drawings which illustrate this article.

The Birmingham Trades Exhibition.

After a lapse of five years owing to the war, this Trades Exhibition has once more made its appearance at the Bingley Hall, Birmingham. Whilst the style and general arrangement are much on the lines of the former shows, some new features have been added, and the engineering exhibits are particularly interesting. Some new electrical devices are being shown.

A triple Auto circuit breaker made by Messrs. **Handley & Robinson, Ltd.**, of Birmingham, is illustrated in Fig. 1. The Company claim that with this automatic circuit breaker, fuses are unnecessary, and if, in a motor circuit, the motor is started too rapidly, it breaks the circuit and does not re-set until the starter arm is returned to the "off" position. It is also claimed to be fully efficient in cases of overload, short circuit or any excessive rise of current from any cause whatsoever. After breaking, it always remains out until the fault is removed, and then automatically re-sets. It is entirely automatic when used with any modern motor starter, and having only two terminals can be used in any part of a circuit where a single pole fuse can be fixed. A magnetic blow-out is fitted which reduces arcing to a minimum. The apparatus embodies few working parts, and there is nothing to get out of order.

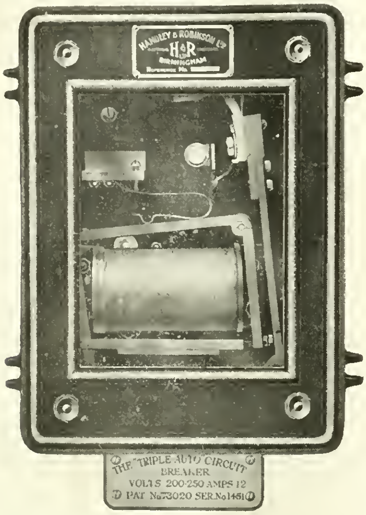


Fig. 1.

A new conduit fitting placed on the market by Messrs. **Massey & Rothschild, Ltd.**, is shown in Fig. 2. This takes the place of the ordinary saddle generally used in conduit wiring, and it is claimed to be much more efficient, requiring only one fixing screw, and permitting of much greater ease of conduit erection. Another distinct advantage is that any part of an installation can be readily taken down at any time for examination or repair, by simply sliding off the cap and pulling out the faulty tube. Wiring in corners is also made possible with the use of this fitting. The Company claim it to be a superior method of securing conduit to any method hitherto placed on the market.

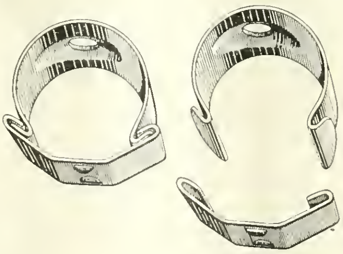


Fig. 2.

The **City of Birmingham Electric Supply Department** are showing a complete range of electrical appliances for domestic and general purposes, including electric radiators, electric light fittings, electro vapour radiators, electric signs, cooking ranges, bath water heaters, washing machines, table appliances, electrically driven machine tools, apparatus used in dental surgery, laundry and domestic irons, and dining-room specialities, such as kettles, toasters, teapots, coffee percolators, &c. The firms represented on their stand are the General Electric Company, The British Thomson-Houston Company, The Premier Electric Heaters, Benham & Sons, Dental Manufacturing Company and Messrs. Belling & Company. The whole exhibit is an example of what might be done by many other Corporations to familiarise the public with electric apparatus. A view of this stand is given in Fig. 3.

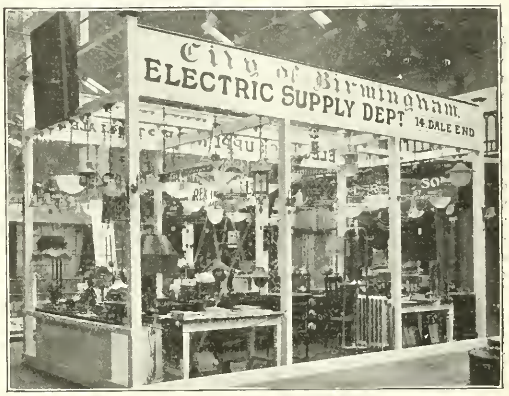


Fig. 3.

Messrs. **E. E. Anderson & Company, Ltd.**, Birmingham, show Ozonair Ltd.'s apparatus for the purification of atmosphere, water, sewage, bleaching of oils, fats and waxes, brewing, therapeutics and food preservation. They also show country house lighting sets, motors, dynamos, accumulators, heating and cooking apparatus. The Idobuff polishing motor, made by **Kenneth Hoggan** of Birmingham, is also exhibited on this stand. Fig. 4 shows a view of the machine which has been specially designed for jewellers and silversmith's requirements in the way of polishing, buffing and scratch brushing. It is made in two sizes, $\frac{1}{4}$ and $\frac{1}{2}$ h.p. and works on a 200-250 volt direct current circuit at 2,250 r.p.m. The spindle is made of a specially tough quality of Bessemer steel, and is mounted on ball bearings giving the machines a very high efficiency. The height of the centre is 9 in., thus doing away with any necessity of packing up from the bench. There is a double pole fool proof type switch enclosed in the base and the finish of the apparatus generally is a remarkably high standard.

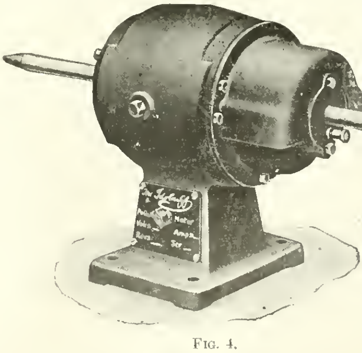


Fig. 4.

Messrs. Charles Purden, of Birmingham, show various sizes of their stock electric motors, also a very comprehensive assortment of lathes, drilling machines, milling machines, and general mill furnishing requirements.

The Electric Appliances Company, Ltd., of London, have an attractively fitted stand, showing their Imperial electric vacuum cleaner.

The largest stand in the Exhibition is that devoted to the Vickers interests. It contains a very comprehensive range of this Company's manufactures, including a collection of drop forgings and stampings of locomotive crank shafts and aero engine crank shafts, and a special display of hardened steel rolls for the non-ferrous metal frames manufactured by the Company at their Sheffield works, Vickers sewing machines, Martini pattern miniature sporting rifle and shot gun tubes, engineers' small tools, brick and concrete brick and tar making machinery, working models of the Williams-Janney variable speed gear, general display of waterproof fabrics and rubber goods made by the Loco Rubber and Waterproof Company, Ltd., Glasgow, surveying instruments, telescopes, tacheometers, a general display of electric fittings, including a dynamo and electric lighting set, electric washing machines and wringers, Vickers patent box making machinery, Spondite glass substitute, Vickers Petters 25 h.p. semi-Diesel Oil Engines. One of the most interesting displays on this stand is the Cosmos Lamp exhibit, showing the various stages in the process of the manufacture of Cosmos lamps.

Machine shop tools and machinery are shown by the following firms:—Messrs. J. Ackworthy, A. Allen & Son, A. Finney & Company, J. Sagar & Company, John M. Terry & Company, Ltd., and Timbrell & Wright Machine Tool Company, Ltd

The Exhibition will be open until May 8th, and is attracting large crowds daily.

Reviews.

Storage Battery Practice. By R. Rankin, B.Sc. (London: Sir Isaac Pitman & Sons.) Pp. xi. + 169. 7s. 6d. net.

In some respects the work of the reviewer is more difficult when reviewing a book that is good than when criticising one that is indifferent, for in the latter case there is ample scope for criticism, whereas in the latter there is a certain monotony in merely expressing agreement from time to time with the author in question. That we feel is the difficulty in the present instance, for there is very little with which we can disagree in the book before us. Moreover, it is short, to the point and, essentially practical, so that it should appeal to every engineer who is responsible for accumulators.

The first chapter discusses very briefly the nature and action of the lead cell. Here we have a little criticism to make, though it may be considered academic. In giving the electro-chemical equations for the reactions at the two plates we think a better idea of what takes place is given by using the ions of the acid rather than the acid molecule itself and by starting with the negative instead of the positive. By so doing, the lead becomes lead sulphate without any mystery of oxygen about it, and the resulting hydrogen is deposited on the positive plate, where it is naturally removed by the depolarising qualities of that plate, reduction taking place with resulting sulphate. The author has followed the converse course, which we do not think is so clear. Another criticism which we would make, of a minor character, is that the word "sulphation" is used to cover both the normal reaction on which the cell depends and the abnormal sulphate which is one of the weak points of the lead cell. We think it is an advantage to restrict the meaning of sulphation.

A feature of the book is that no cells, plates or apparatus are described by name, except automobile cells. This permits a certain freedom in criticism, and those who are familiar with the subject will be able to supply the names for themselves.

Chapters II.-IV. describe the manufacture, setting to work and properties of accumulators, and from his experience as the engineer of one of our leading accumulator manufacturers for a number of years the author is able to include information of a very useful kind. The application of the cadmium electrode is given in greater detail than we remember seeing before; and it is shown how to deduce a very useful series of curves of available capacities and available voltages from the usual discharge curves at various rates. The author appears to hold the view that the reactions on discharge start from the surface of the plates, though we believe it has been more generally held that they start from the grid or lead. It would be interesting to have the evidence for and against these views. The most reasonable supposition would seem to be that the action starts from the grid in the case of the positive and from the outside surface in the case of the negative.

Chapter V., on the practical working of cells, is the most generally useful part of the book and it is excellent. It would be well if every engineer having charge of accumulators would learn this chapter off by heart. Far less would then be heard of battery failures and falling capacity. Emphasis is laid upon the folly of the 10 per cent. overcharge rule, by which it is sometimes thought that any battery can be kept in order; and upon the inadvisability of trusting to the accuracy of cheap switchboard instruments when an error in the limiting discharge voltage may lead to serious injury of a costly battery. This chapter is followed by a useful account of overhauls and repairs.

In Chapter VII. the author discusses the uses and operation of stationary batteries, including the use of boosters a subject to which he has devoted considerable attention. Some striking diagrams are given showing the much greater effectiveness of external control as compared with diverter control in booster working.

The concluding chapter describes briefly special batteries for train lighting and automobile work, including the Edison and Alklum cells and the Ironclad Exide cell. We think the last-named merits a more detailed description than is here given, for it is somewhat unique in construction.

The book is well printed and we have only noticed one misprint, which we would ask the author to note as it is a little confusing. At the top of page 9 the word "cored" occurs twice in consecutive lines, whereas in the second line the word should apparently be "uncored."

From what we have said, our readers will gather that Mr. Rankin's book is a welcome addition to the literature on the subject, and as it is short and inexpensive (as prices go in these days) it should be widely read. W. R. Cooper.

Molecular Physics. By J. A. Crowther, Sc.D. 2nd Edition. (London: J. & A. Churchill.) Pp. viii. + 190. 6s. net.

Students of physics will welcome the second edition of this little book. The main difference between this and the first edition is the inclusion of a new chapter dealing with the work of Sir Ernest Rutherford on the structure of the atom.

The book is valuable in that it presents in a handy form a great deal of work which previously was not so readily accessible. It is of interest not merely to the pure physicist, but to all who are concerned with thermionic values and similar applications of the electron.

Correspondence.

THE LARYNGAPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the issue of The Electrician of the 19th inst., an account is given of the "Laryngaphone," in which it is stated that: "essentially it is a telephone with a throat transmitter such as was developed during the War for aeroplane work." We beg to state that the only throat transmitter used successfully by the Royal Air Force during the War was that manufactured by the Relay Automatic Telephone Company, who also hold the patent rights. We have authority for stating that the "Laryngaphone" was not used in any way during the War by the Royal Air Force.—I am, &c.

London, March 29. C. B. Clay.

The Electrician.
FRIDAY, APRIL 9th, 1920.
Price ONE SHILLING. By Post 1s. 1d. Ann. Sub.: U.K. 52s., Abroad 54s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

The Institution and Its Council.

On another page of this issue will be found the official nominations for the vacancies on the Council of the Institution of Electrical Engineers which will occur on September 30th, 1920. Within narrow limits it is now for members to determine who are to represent them on the Council during the coming Session. Mr. Ll. B. Atkinson is put forward for the office of President, Dr. W. H. Eccles and Messrs. J. S. Highfield and S. L. Pearce are recommended for the three vacancies on the vice-presidents' list, and eight members are nominated for the six vacancies which will occur among the ordinary members of the Council. Unless, as is permitted by Article 50 of the Articles of Association, any unofficial nominations are received before April 21st, the election this year will not be very exciting. For it will be noted that members as a whole will have no say in the election of any class of official but that of ordinary members of the Council, and here there is only a limited choice.

Mr. Atkinson's Position.

Our views as to the qualifications of those who are to form the Council of the Institution of Electrical Engineers were published a week or two ago and we do not propose to reiterate them here. But there are one or two other points to which there will be no harm in calling attention. The President holds a most important position. He is not only titular head of an important profession, but should be its Speaker as well. Mr. Atkinson's career has been along commercial and technical lines. He is familiar with the ways of commerce and has, we believe, also had some experience of the methods of officialdom. This is all in his favour, and we wish him success.

The Balance of Representation.

Turning to the vice-president and ordinary members of the Council, if we combine those remaining in office with the new nominees there are 25 members to fill 22 vacancies. Of these, three, including one vice-president and one new nominee, represent the educational section, eight, including three new nominees, the manufacturing and contracting element, and seven, including the honorary treasurer and one vice-president, traction, light and power interests. One vice-president is a consultant, two new nominees represent telegraphs and telephones and four, including two nominees, miscellaneous divisions such as law, Government Departments, &c. The Council, we are often told, should be thoroughly representative of all classes of the industry. But such an ideal is not easy to reach. This year it will be a very pretty problem how to vote to secure the most equal representation of every interest. We do not think it can be done. It may be noted, however, that education and the supply authorities are well represented and will continue to be well represented whatever the result of the election; consulting engineering, when the past presidents are taken into consideration, will have no cause to grumble, but telegraphs and telephones may be badly left, as the only representatives of these classes are new men who may fail to secure election.

It is pretty evident, therefore, that someone will be disappointed. Not that in our opinion this matters much, as the representative idea can be overdone. A Council is like a football team in which the individual brilliance of its members is of less account than its performance as a body.

What Members Must Do.

On the nominees, as nominees, we therefore make no comment, because that side of the question is relatively unimportant. But we do most earnestly impress upon members that they have it in their own hands to elect any Council they wish and that in allowing some of the members who have served on the Council in the past even to have been nominated they have shown great neglect of their own interests. We hope that this year no such neglect will be shown, and that if members are not satisfied with the Council's nominees they will put forward others. And that even if they are satisfied they will show enough interest to vote.

Is it Impossible to Obtain New Blood?

We were told the other day that the membership of the Institution had never been so large and was rapidly growing. Yet the same names appear and re-appear on the list of those available for election to the Council, and there is the same latent dissatisfaction with the composition and the doings of that body. Any improvement is, of course, to a large extent in the hands of members themselves, but there are one or two matters which the Council themselves might take in hand. For instance, the policy with regard to nominating a member for a second term of office on the Council seems to require amendment. In the present list we believe we are right in saying that one at least of the nominees for the vice-presidency has already served in that office, and that of the nominees as members of the Council one has served as vice-president and another has served a term on the Council. This is rather hard on other deserving cases; or are we really so short of suitable candidates?

The vice-presidency at present is rather an anomalous office with a little dignity but few responsibilities. But surely it should be second only to the presidency in both. Indeed, when a member is nominated to that office he should be regarded as a possible candidate for the presidency within an easily calculable period. He should not be allowed simply to disappear at the end of his term of office, only to receive later on Irish promotion as an ordinary member of the Council. The same applies to nominations for a second term. A member who has greatly distinguished himself as an ordinary member of the Council should be next considered for the office of vice-president, with the reservation that we feel that no member should pass from ordinary membership of the Council to the vice-presidency without a period in retirement. To allow such an arrangement is again to admit a paucity of suitable candidates.

The Proper Position of the Council.

These suggestions are put forward in no captious spirit and least of all are they meant to be personal. But we view with regret the attitude with which the Council is regarded by a large body of members, and we think that something should be speedily done to bring about a change. We also feel it to be essential that the Council should lead the profession. But this it cannot do unless it possesses the confidence of the whole body of members. To obtain and keep this confidence certain reforms are necessary of which the most important is that members should take a more active part in the nominations and elections to the Council each year. As a prelude to change grumbling might give place to action.

Heating and Cooking Notes.

Drying Ovens.

There are a variety of industrial processes in which steam or gas are at present employed as the heating agent for drying and baking purposes. In the majority of these electricity would be a far more suitable heating agent because the temperature of an electrically heated oven can be exactly and economically controlled. Thermostatic control in conjunction with a time switch allows the ovens to be put on circuit for heating up purposes before the normal time of commencing work in the factory and therefore the ovens are quite ready for use when the works open in the morning. This operation is entirely independent of the attention of a night watchman, neither is it necessary for an employee to attend before opening time. Further, electricity in cases where an oxidising atmosphere is required does not vitiate the atmosphere, neither are fumes created which may have a deleterious effect on the goods or material under treatment. In many cases, particularly in connection with drying operations, a high oven temperature is not required and therefore the heating elements will last for a very long time because it is not necessary to run them at a radiant temperature. This factor makes such ovens very reliable and it is somewhat surprising that greater efforts have not been made by supply authorities to promote a greater demand for this class of apparatus.

The load offered, though perhaps not particularly high per oven, is generally at the off peak period and in many instances can be a night load. Fig. 1 illustrates a typical form of electric drying oven, manufactured by Messrs. Automatic & Electric Furnaces, Ltd. It is one of a standard range of ovens made by this firm, and is constructed of polished sheet metal and has a heating chamber 23 in. by 19 in. by 19 in. Larger sizes can be supplied where required. Grid shelves are provided to carry the articles to be dried. The heating element is fixed at the bottom of the oven and is protected from injury by means of a specially designed convector plate which also aids in evenly distributing the heat. Air inlets are provided at the base of the oven and an adjustable ventilator outlet at the top. The design of the air inlets and outlet and the convector plate are based on results obtained from a prolonged series of experiments, and it is claimed that the design adopted provides for equitable heating throughout the oven and that the creation of cool air pockets is entirely prevented.

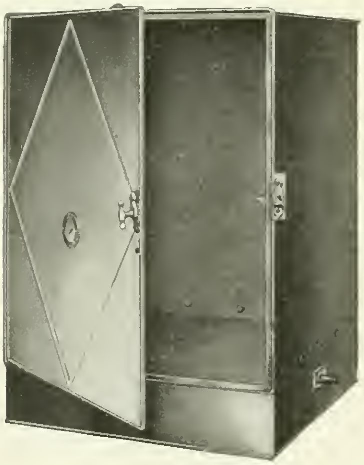


Fig. 1.—Electric Drying Oven by Automatic & Electric Furnaces, Ltd.

An oven of the above dimensions is loaded to 650 watts and a temperature range of from 215°F. to 250°F. can be obtained by adjusting the regulator. An indicating thermometer is supplied when asked for. The element is sufficiently highly rated to give quick heating up with doors shut and the oven empty, and naturally when charged the time taken to heat up is prolonged in relation to the weight of the charge and the amount of moisture that has to be evaporated.

"Creda" Electric Hot Plates.

Messrs. Credenda Conduits, Ltd., have supplied us with particulars of an interesting range of hot-plates and warming-plates manufactured by them and supplied under the well-known brand name of "Creda." For kitchen and industrial purposes where the roughest usage is met with, the enclosed type of hot-plate (H. 129-134) is recommended. This consists essentially of the ordinary enclosed hot-plate mounted on three small legs and provided with a machined cast-iron top. This type of hot-plate naturally suffers from the disadvantages that there is a time lag whilst the hot-plate is heated up and a consequent wastage if the residual heat is not used for heating a second utensil after the first is finished with. To overcome this disadvantage and still to retain as much of the robustness in design as possible to withstand rough usage an enclosed type of hot-plate made on similar lines is provided but the machined cast-iron top is replaced by a stamped steel top. This stamped steel top, as will be seen from the illustration in Fig. 2, is not provided with an entirely flat surface, and the particular design adopted should tend to minimise the risk of buckling, a disadvantage which has affected many enclosed hot-plates and which is an important point, where heat transmission is entirely dependent on conduction. The thinner stamped steel top, of course, allows for quicker heating up than can be obtained with the machined cast-iron top. The number of this type of hot-plate is H. 135.

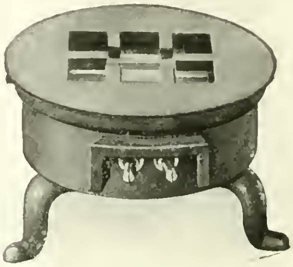


Fig. 2. Enclosed Type "Creda" Hot-Plate.
(With stamped steel top. 8¼ in. diameter. 1,000 watts.)

"Creda" radiant type hot-plates are also made and therefore those persons who do not wish to use or purchase special flat-bottomed utensils, are catered for. The radiant hot-plates are numbered H. 400-402. In loading the hot-plates range from 400 to 1,500 watts, and in diameter from 5¼ in. to 11 in., the radiant type being the largest in diameter and naturally the more highly loaded. In all the larger sizes three heat control is provided, viz., low, medium and full heat, by means of three plug-type connectors. The warming plates are comparatively lightly loaded pieces of apparatus intended for use on the dining table, or sideboard, or on serving tables in restaurants. A variety of types are made, both ornamental and plain, and as in the case of the hot-plates two forms of top are employed either machined cast-iron or polished aluminium. The cast-iron tops are used on the restaurant or plain but substantial types, and aluminium is employed in the more elaborate patterns. Heat control is provided for on the restaurant types, which range in surface area from 120 sq. in. to 260 sq. in., and in consumption from 1 kw. to 3 kw.

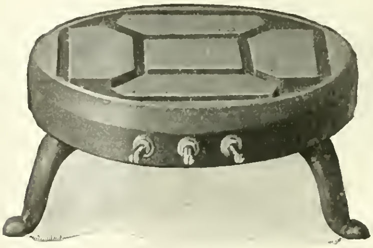


Fig. 3.—"Creda" Open Type Boiling Plate.

The Institution of Electrical Engineers.

The following have been nominated by the Council for the vacancies which will occur in the offices of President, Vice-Presidents, Honorary Treasurer, and Ordinary Members of Council on Sept. 30, 1920:—

President. (One Vacancy.)

Ll. B. Atkinson ... Cable Maker.

Vice-Presidents. (Three Vacancies.)

Dr. W. H. Eccles ... Prof. of Electrical Engineering and Applied Physics, City and Guilds Technical College.
J. S. Highfield ... Consulting Engineer.
S. L. Pearce, C.B.E. ... Chief Engineer, Manchester Corporation Electricity Department.

Honorary Treasurer. (One Vacancy.)

J. Devonshire, K.B.E. Managing Director, London & Suburban Traction Company, Ltd.

Ordinary Members of Council. Members. (Six Vacancies.)

F. Gill ... ... European Chief Engineer, International Western Electric Company.
P. V. Hunter ... ... Joint Manager, Callender's Cable & Construction Company, Ltd.
J. F. Nielson ... ... Electrical Engineer, Messrs. John Brown & Company, Ltd.
W. Noble ... ... Engineer-in-Chief, General Post Office, E.C.
A. P. Pyne ... ... Director, Redheugh Iron & Steel Company, Ltd.
Dr. A. Russell ... Principal, Electrical Standardising, Testing and Training Institution.
F. Ryan ... ... Chief Engineer, Eastern & Associated Telegraph Companies.
W. O. Smith ... ... Director, Messrs. Elliott Bros. (London), Ltd.

Those retiring from the present Council and not put forward for re-election are Mr. Roger T. Smith (President), Messrs. G. W. Partridge and W. B. Woodhouse (Vice-Presidents), Sir R. A. Hadfield, Bart., F.R.S., Sir W. Slingo, Col. H. C. Sparks, C.M.G., D.S.O., M.C., and Mr. A. P. Trotter (Members of the Council). Of the remainder of the present Council who would ordinarily retire on September 30, 1920, Mr. Ll. B. Atkinson, Dr. W. H. Eccles, and Mr. J. S. Highfield are put forward for higher office.

The branches of the profession represented by the new nominees and by those remaining on the Council are shown hereunder, the new nominees being indicated in italics. Educational: *Dr. W. H. Eccles*, Dr. E. W. Marchant, *Dr. A. Russell*. Manufacturers and Contractors (*a*) Traction, Light and Power: H. J. Cash, H. W. Clothier, D. N. Dunlop, E. A. Gatehouse, *W. O. Smith*; (*b*) Cables, *P. V. Hunter*, B. Welbourn; (*c*) Telegraphs and Telephones, *F. Gill*. Traction, Light and Power (*a*) Companies (excluding railways): W. A. Chamen (Vice-President), *J. Devonshire* (Hon. Treasurer), P. D. Tuckett; (*b*) Local Authorities, J. R. Cowie, S. E. Fedden, *S. L. Pearce, C.B.E.* (Vice-President); (*c*) Railways: J. Sayers. Consultants: *J. S. Highfield* (Vice-President). Telegraphs and Telephones (excluding manufacturers): *W. Noble*, *F. Ryan*. Miscellaneous (*i.e.*, Law, Government Depts., other than Post Office, Electro-Chemistry, Research, &c.): P. R. Allen, *J. F. Nielson*, C. C. Paterson, O.B.E., *A. P. Pyne*.

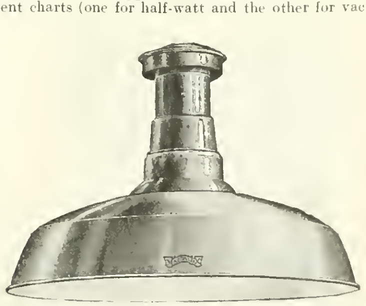
Members are reminded that under Article 50 of the Articles of Association any ten full members may nominate a qualified person to fill a vacancy on the Council by delivering such nomination in writing, together with the written consent of the person nominated, before April 21st.

The new President, Mr. Llewelyn B. Atkinson, M.I.E.E., A.M.Inst.C.E., was born at Builth Wells, Breconshire, where his father, also a civil engineer, was engaged on laying out the Cambrian Railway. He was educated at the Merchant Taylors School, where he studied physics and chemistry, and though he won an exhibition to St. Thomas' Hospital, he decided to follow electrical engineering, and in 1880 he attended evening classes under Prof. Ayrton at Cowper-street Schools, Finsbury. He was awarded the 1st prize and silver medal in electrical technology in 1881. At that time electrical engineering was booming, and although he was offered a great variety of posts he decided to go through a complete engineering training, first at King's College (London) engineering department, where he numbered among his fellow students Mr. C. H. Wordingham, and afterwards at Messrs. Kitson & Company's Airedale Works, Leeds. In 1886 he became articled to Goolden & Trotter, and in 1888, on the retirement of Mr. Trotter, he joined Mr. Goolden as partner. The firm's works, which were moved to London in 1889, developed the manufacture of dynamos, motors and electrical instruments (the latter under the guidance of Mr. Evershed), and particularly electric mining machinery. In 1887 Mr. Atkinson had begun work on this subject, and patents for electric coal cutters and other applications of electricity to mining rapidly resulted. In 1891, with Mr. C. W. Atkinson (a younger brother), he read a Paper before the Institution of Civil Engineers on "Electrical Mining Machinery," for which the Telford gold medal and premium were awarded. When the firm amalgamated with Messrs. Easton & Anderson, under the title of Easton, Anderson & Goolden, Ltd., in 1893, Mr. Atkinson became a director of the new company, but he retired from it in 1897. In 1898 he read a Paper before the Institution of Civil Engineers on "The Theory, Design and Working of Alternate Current Motors," which was awarded a Telford premium. A writer in the "Journal" of the I.E.E. seven years later stated that in this Paper was to be found "the germ of almost every improvement which has been made known up to the present in respect to the compensation and regulation of commutator motors." In 1900, in association with the late Mr. Faweus and others, he founded the Trafford Power and Light Supply Company, Ltd., perhaps the first company ever founded primarily to distribute power to an industrial area. There were great difficulties at first, but finally the company overcame them, and has been a pioneer of low cost supply. Mr. Atkinson was for nearly 20 years a director of this company, which was recently acquired by Stretford Urban Council. On the reorganisation of W. T. Glover & Company, Ltd., in 1903 he was invited to become director, and later was in charge of their London office. He remained in this position till 1916, when he gave up executive duties, remaining on the Board until 1919, when the company was acquired by Vickers, Ltd. From 1903 he has taken a prominent part in the affairs of the Cable Makers Association, having been at one time Chairman, and in 1916 he succeeded the late Mr. A. H. Howard as secretary, a position which he still holds. Mr. Atkinson became a member of I.E.E. in 1900; he was elected a member of the Council in 1916, a V.P. in 1919. In 1918 he delivered the tenth "Kelvin" lecture on "The Dynamical Theory of Electric Engines." He is a member of the Electrical Sectional Committee of the British Engineering Standards Association, a representative of the I.E.E. on the Electrical Research Committee, and a representative of the C.M.A. on the Electrical Developments Association. For many years he has been a member of the Electro-dynamicables, of the 25 Club, of the Electro-Harmonic and other electrical societies representing the industry in its light side. At one time Mr. Atkinson was a regular and valued contributor to The Electrician.

Mazdalux Reflectors.

In the industrial lighting field, the introduction of scientific methods and designs may be said to date from some nine years ago, a period coincident with the development (by the British Thomson-Houston Company, Ltd.), of the Mazdalux reflector. The increasing use of these efficient re-directors of light has contributed in a great measure to the increasing interest displayed by factory owners and managers in the question of artificial illumination. A comparison of the first Mazdalux price list with the catalogue recently issued would provide an interesting historical commentary on the remarkable advance which has taken place during the last few years in the industrial applications of electric light. The original Mazdalux catalogue contained a very restricted range, but the present list contains 30 pages, illustrates and describes nine different types of reflectors, some for use with half-watt and others for use with vacuum type Mazda lamps, and reproduces photographs of 18 typical Mazdalux installations, which, of course, represent an inconsiderable proportion of the total.

The opening section of the new catalogue contains full information as to the characteristics and application of Mazdalux reflectors, including two excellent charts (one for half-watt and the other for vacuum type lamps) which should be of great assistance in planning lighting installations. An admirable arrangement has been adopted in the body of the list, whereby the illustration, specification, prices and polar curve of a particular reflector are given on the left-hand page, while the facing right-hand page contains illustrations of Mazdalux installations. Other useful information includes a glossary of the terms employed in illuminating engineering, detailed illustrations and descriptions of the various types of caps and weatherproof housings used on Mazdalux reflectors, particulars of reflectors accessories, &c. Our illustration shows the dispersive type of reflector for half-watt lamps with adjustable housing. Readers who desire copies of the price list (No. 10,336A) should write to the Publicity Department of the Company at 77, Upper Thames-street, London, E.C.4.



View of Modern "Mazdalux" Reflector.

A Portable Wireless Receiver.

We give below a brief description of the portable receiver used in a demonstration by Mr. R. C. Clinker at a recent meeting of the Wireless Society of London.

This set, which measures 13 in. by 14 in. by 5 in., is completely self-contained, and comprises a receiving coil, tuning condenser, two B.T.-H. valves, an accumulator, a dry battery, transformers, and a reaction coil. The receiving coil is wound upon a frame, which fits inside the outer case, with a small air space between the coil and the case. Inside the receiving coil is placed all the apparatus enumerated above. The cover is fitted with "lift-off" hinges, and has fixed on its inside face a projecting pin, surrounding which is a large circular scale marked with the points of the compass. The case has a co-operating socket let into its base, which allows the whole set to be placed on the pivot, and turned easily on a vertical axis, so that the line of direction in which the received signals are travelling can be found. A small compass card fixed to the cover enables the latter to be placed approximately correct relatively to the points of the compass. These details are seen in the illustrations.

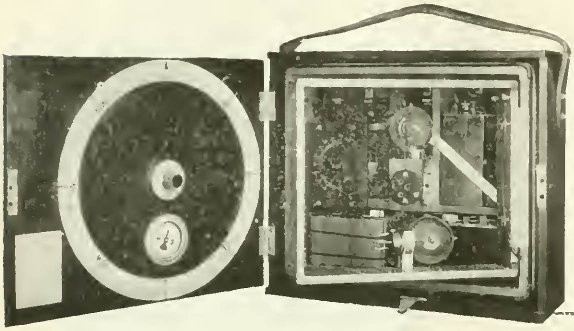


Fig. 1.—B.T.-H. Portable Wireless Receiver with Cover Open.

The connections of the set are such that the first valve is used as a detector, and the second as a low frequency amplifier. A hinged reaction coil is provided which is connected in the "plate" circuit of the first valve, and the coupling of which to the receiving coil may be varied by adjustment of its angular position. At a certain closeness of coupling, the detecting valve commences to oscillate at a frequency depending upon the inductance of the receiving coil and the capacity of the adjustable condenser connected across it.

When signals are to be received, whether from spark or continuous wave stations, the condenser is set to give the correct wave-length, and the reaction coil is closed in until oscillation commences, when the signals are heard. Spark stations also are thus "heterodyned," and their true notes are modified, but can be read clearly. The set can be provided with sufficient capacity to tune between the limits of 2,000 and 15,000 metres wave-length, so that Paris time signals can be taken, and long wave stations such as Carnarvon and Lyons read. In all, about a dozen of the largest stations in England, France, and Germany may be read, and several more heard without any additional wire. The signals obtained thus, while not, of course, exceedingly loud, are clearly readable in a reasonably quiet room. To obtain the direction from which signals are coming, the case is rotated on its pivot until the signals sink to a minimum or become inaudible. A pointer then indicates on the scale the direction, or 180 deg. removed from it.

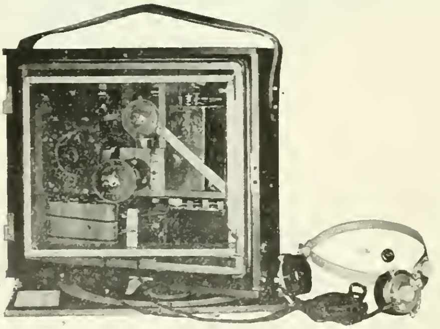


Fig. 2.—B.T.-H. Portable Wireless Receiver Mounted on a Pivot on Cover, with Telephone Connected Ready for Use.

The accumulator is of an "unspillable" type, and can be sent out with the set, ready charged for immediate use. A plug switch is provided for lighting the valve filaments, the handle of the plug being of such length as to prevent the case from closing if the filaments have been left alight. The weight of the complete set is 20 lb.

We are indebted to the British Thomson-Houston Company for the information given in and the blocks illustrating this article.

The Electric Lamp Industry.

The Electric Lamp Manufacturers' Association, through its director (Mr. J. E. Edgecombe), has issued a reply to the recent report of the Sub-Committee of the Standing Committee on Trusts in connection with electric lamps, which challenges the findings of the Committee and gives tables to show the great increase in cost of production since 1913 of the four original Association firms and also the prices received in 1913 and 1919. From these tables it appears that, in spite of greatly increased costs of production, the prices only rose about one-fifth as much as the general rise of retail prices, while the rate of profit decreased by more than 50 per cent.

It is claimed that the average discount in the lamp trade is not to-day higher than the average discount on other electrical supplies, and it is alleged that the Committee has seriously misrepresented the effect of the existing trade arrangements. No trader signs the factors' agreement; it is only signed by factors who are in effect exclusive agents for Association lamps. No other agreement is entered into which forbids the sale of non-association makes.

Patents and Licences.

The Association business is mainly founded upon patent rights. The patent is a legal monopoly granted for reasons of public policy, and the patentee should not—it is urged—be attacked on the ground of this monopoly, provided that he puts it to reasonable use. When the Association came into existence the resources of the three patent-owning firms were sufficient to build factories big enough to meet the demand of the country, and they could ultimately have shut down all the existing lamp works. They did, however, nothing of the kind, but, on the contrary, licences were offered by them to all existing manufacturers.

The Dutch Lamps.

The charges that one and a quarter million half-watt lamps were purchased in Holland at 3s. and sold to the public in 1919 at 12s. 6d. each, and that the "Importers and distributors between them made profits amounting to £280,000 over and above what the Committee considered reasonable," are said to be devoid of foundation. The lamps in question were not sold to the public, but to Government Departments, controlled factories, shipyards, railways and similar places to replace arc lamps which could not be used owing to the scarcity of carbons and labour. By chance, 1 or 2 per cent. might have drifted into the hands of the public, whereas 97 or 98 per cent. went to the large consumers, not at 12s. 6d., but at about 8s. 3d., which is approximately the Committee's recommendation. It was not to the interest of British makers to import Dutch lamps; their importation was part of the price to be paid for the assistance of a Dutch competing firm in building an Argon plant in England during the war. Owing to the absence of such plants, the scarcity of steel and building materials, &c., British manufacturers could not develop the half-watt lamp during the war, and yet there was a great demand for them for war work.

The Association state: "It is regrettable that the Committee did not accept our invitation to visit a big lamp factory which would have better illustrated to them what are the risks connected with the starting of a new industry based on patents. Without such a study, they could not appreciate what cost was borne by the pioneer firms in research, in purchase of patents, in the building and equipment of works, in experiments with machinery (which, in six years, had to be replaced three times), in the cost of training labour, the cost of unsaleable goods turned out faulty at the beginning through want of skill and experience, the cost of experts and patent litigation, all of which costs have been borne by the three patent-owning firms." The total lamp turnover of the Associated firms is only £3,000,000 per annum, or, after allowing the charges of distribution, an average of 1s. 9d. per head of the population. The total sum expended on lamp research alone during the last 11 years amounts approximately to £364,000, with a present annual approximate expenditure of £50,000.

The reply concludes: "The Committee, who seem to have been deliberately chosen for their lack of knowledge of the electrical industry (presumably in order to secure impartial judgment), held only nine sittings. In this short time they attempted to take, to consider, and to report upon evidence in minute detail upon a large and complicated subject. It can hardly be wondered that, in such haste, they have ignored the economic position of the industry in the national life and the necessity of safe-guarding a vital key industry to the nation. Ill-considered judgments of this kind when issued under the authority and direction of a Government department cannot fail to have the most mischievous results."

Civilian War Honours.

In the recent list of 5,604 promotions in and appointments to the Civil Division of the Order of the British Empire for services in connection with the War we notice the names of a number of gentlemen prominently associated with the various branches of electrical engineering and with physical science, &c., and among these are the following:—

Knights Grand Cross.—Viscount Chilston and Sir John Denison-Pender, K.C.M.G.

Knights Commanders.—Prof. Wm. Henry Bragg, C.B.E., D.Sc., F.R.S., Henry A. Colefax, K.C., James L. Devonshire, John Dewrance, George K. B. Elphinstone, Arnold B. Gridley, Prof. J. E. Petavel, D.Sc., F.R.S., Harry B. Renwick.

Commanders.—James Anderson, Hubert Baines, O.B.E., Douglas H. Baird, Herbert E. Blain, Prof. Hugh L. Callendar, F.R.S., LL.D., James Dalrymple, Reg. A. Dalzell, Prof. F. G. Donnan, F.R.S., Aubrey Ll. C. Fell, Prof. P. F. Frankland, F.R.S., D.Sc., John B. Hamilton, Richard J. Howley, Arnold H. Human, Geo. W. Humphreys, Prof. J. C. Irvine, D.Sc., F.R.S., Charles Le Maistre, George F. Preston, Capt. Matthew H. P. R. Sankey, C.B., John E. Sears, jun., Francis J. Selby, Charles P. Sparks, Thomas E. Stanton, D.Sc.

Officers.—Wilfred C. Acfield, Percy R. Allen, Peter F. B. Bennett, Robert P. Brousson, Samuel Flint, Thomas B. Goodyer, Alex. R. Horne, Commander James Hunter, R.N.R., Capt. Harold F. Lardner, Prof. Frederick C. Lea, D.Sc., Cecil C. Mason, Prof. Gilbert T. Morgan, D.Sc., F.R.S., Frank S. Muirhead, Samuel Alex. Pollock, James S. Pringle, Charles Rogers, Hugh I. Rogers, Oscar F. A. Sandberg, Josiah Sayers, John Sinnott, Christopher J. Spencer, Arthur J. Stopher, Charles E. Stromeyer, Colin P. Sutthery, Prof. William M. Thornton, D.Sc., D.Eng., George Tough, Alfred De Turckheim, Philip J. Watts, Ernest Thomas Williams.

Members.—John H. O. Barnard, Harry Brakes, George A. Carr, Frederick S. Corns, Major Frederick Coutts, T.D.; Charles W. Edwardes, Edward C. S. Elmslie, Harry England, Herbert Finnis, Frederick L. Fisher, Albert E. Frankling, Frederick H. Gardiner, Lawrence Gibson, William E. Hardy, Frederick J. Harlow, Thomas T. Hodgkinson, Thomas Hornbuckle, Robert L. Horsfield, George R. Hulme, Llewellyn T. Jones, Noel J. C. Lawson, Geo. Lee, Josiah Macey, Peter Mackenzie, Frank B. Miall, Josiah Priest, Frederick Wm. Reid, Thomas Reid, William T. Robson, Frederick H. Rolt, Francis W. Tierney, Albert R. Lochlein-Todd, Victor Watlington, Harris Watson, James N. Wilson, Nathaniel J. Young.

It will be seen that the list is comprehensive, and includes representatives of the electricity supply industry, electric railway and tramway managers, telegraphy and telephony, professors of physics and electrical engineering, &c. Sir John Denison-Pender, K.C.M.G., who has been created a G.B.E., is chairman and managing director of the Eastern and South African, the West African and other telegraph companies. He is a son of the late Sir John Pender, G.C.M.G., and he has been associated with submarine telegraphy since 1881, when he became a director of the Eastern Telegraph Company. During the war the company, as well as its associated companies, rendered conspicuous service to the Empire, a fact which is recognised by the bestowal of honours on several of the commanders of the company's cable fleet and on its telegraph superintendents and engineers.

Viscount Chilston, who is chairman of the Tramways, Light and Power Company, Ltd., was chief County director of the British Red Cross Society.

Of the K.B.E.'s, Mr. Harry Benedetto Renwick will be well known to our readers for his long association with the electric supply industry. He did a considerable amount of valuable Government work in his office of Director of Feeding Stuffs during the war, and has done signal service to the electric supply industry in connection with the recent Electricity Supply Act and other schemes for the reorganisation of electricity supply. He is connected with several important electric supply undertakings, including the County of London Electric Supply Company, of which he is the managing director.

Prof. W. H. Bragg is President of the Physical Society, and a member of the Oxford and Cambridge Universities' Royal Commission. During the war he was on the Board of Inventions panel, and had charge of their Experimental Station, first at Aberdour (Fifeshire) and afterwards at Parkeston Quay. In 1918 he was at the Admiralty as Scientific Adviser to the Director of the Anti-Submarine Division. It is curious that Prof. Bragg's son (Major Bragg), who shared with him the Nobel Prize, the Barnard medal and the medal of the Italian Physical Society, was in charge of the technical side of the sound-ranging work in France, and he is now Langworthy Professor of Physics in Sir Ernest Rutherford's place at Manchester.

Mr. Arnold B. Gridley was director of electric power supply and electrical adviser to the Ministry of Munitions until the 31st ult., when he retired. Mr. George K. B. Elphinstone, M.I.E.E., who is technical head of Messrs. Elliott Brothers (London), Ltd. (the well-known electrical and scientific instrument makers), designed and manufactured fire control apparatus for the Navy. Mr. James Devonshire, who is managing director of the Metropolitan Electric Tramways, the London United Tramways and the London and Suburban Traction Company, was chairman of the Tramways Committee of the Board of Trade. Mr. John Dewrance is chairman of Messrs. Babcock & Wilcox; he acted as a member of the Engineering Employers' Consultative Committee of the Ministry of Munitions and did other work. Prof. J. E. Petavel is director of the National Physical Laboratory, but during the war he was chairman of the Aero-Dynamics Sub-Committee of the Advisory Committee on Aeronautics. Mr. Colefax, K.C., is a well-known patent lawyer.

Legal Intelligence.

Half-Watt Lamp Patent Litigation.

On the 31st ult., Mr. Justice Sargant delivered his considered judgment in the action brought by the British Thomson Houston Company, Ltd., against the Corona Lamp Works, Ltd., for an injunction to restrain an alleged infringement of their patent, which was granted in 1913 for improvements in incandescent electric lamps. His Lordship said the lamp in question was the gas filled lamp, and was popularly known as the half-watt lamp. The efficiency of the lamp depended upon many things, such as the degree of temperature, the inertness of the gas and the conductivity of the heat. It was difficult, therefore, in making any comparison to keep clear of the many variations which governed the question. There was the further difficulty of dealing with the question of voltage owing to the difference in the practice in America and this country. After referring to the general history of the electric lamp, he said that up to 1913 the incandescent lamp in general use was the Tungsten vacuous incandescent lamp, and during the development of that lamp the whole tendency was to obtain a more perfect vacuum, and a good many attempts were made to produce a good gas-filled incandescent lamp. None of the attempts up to 1913 led to any useful results, and no gas-filled lamp was then on the market. It was in these circumstances that plaintiffs produced their invention. The key-note of the patent was struck on the first pages of the specification, which described it as "relating to a gas-filled lamp of higher efficiency than the best lamp on the market" The specification went on to say that it was possible to manufacture a tungsten or other refractory metal gas-filled lamp in which the loss of energy due to heat conduction and convection could be compensated if the gas employed was chemically inert and of relatively high pressure, and the filament was made of large diameter or cross-section or in a concentrated form. He took the view pressed upon him by plaintiffs that the words "concentrated form" meant a filament which, though not originally thick, had been rendered thick for the purposes of the lamp by being closely coiled. The half-watt lamp used in this country was a lamp constructed with a comparatively thin filament which had been coiled thick, gas-filled lamps with uncoiled filaments being commercially unknown here. There were all the usual defences, but ultimately they were reduced to three—viz., want of invention or subject matter, insufficiency, and non-infringement.

Of these the third might be shortly disposed of. A case for infringement had been completely established on the evidence. He thought the diameter of the coil of defendants' lamp, 8·5 mils, was substantially of the order of 10 mils, and the figure clearly indicated that it was a thick filament according to plaintiffs' specifications, and defendants' lamp, therefore, fell within the description contained in plaintiffs' specification. On the question of subject matter, defendants contended that all the elements of the problem were completely known before 1913, and that the patentees had only applied this knowledge to the materials which had come into use, such as drawn tungsten filaments, and purely inert gases, and perhaps the bulbs were made of glass containing fewer impurities. With regard to the prior specification, his Lordship said it had to be remembered that up to the time of plaintiffs' patent the trend had for many years past been in the direction of a more and more perfect vacuum, and gas-filled lamps were not commercially saleable. The utilisation of the new discovery to obtain high incandescence and high efficiency by what was at first blush a retrogressive step, was an inventive step of a high order of merit as well as of the greatest practical utility. Therefore he did not think that the disclosures in the specification mentioned deprived plaintiffs' patent of subject matter. Coming to the third and most important objection—viz., want of sufficiency, he said the objection turned on the use of the word "large," 10 mils was indicated as a large diameter, and was recognised as such; while, on the other hand, 3 mils seemed to be indicated as a small diameter. As to the meaning of the word "large," he had come to the conclusion that the true view to take was that the word must not be regarded absolutely in relation to mere diameter, but meant sufficiently large to take advantage of the new discovery as to a convection or conduction losses, and accordingly to produce such a combination that a much higher temperature and incandescence might be obtained with a commercial length of life. On this view there was sufficient definition by the patentees of the ambit of their claim. But the method of giving effect to the discovery was one of degree, and the only change that was claimed was the change of degree of the thickness of the filament used. A degree of thickness that had to be ascertained not merely quantitatively, but in relation to many other factors was a poor indication to the world at large of that which the patentees were claiming to monopolise. Apparently, a lamp maker desirous of avoiding infringement must make elaborate experiments to ascertain whether his gas-filled lamp had such a degree of efficiency and length of life as to fall within the patent; that was, he might be in danger of being challenged by the patentee. The patentees might have limited their claim so as not to be subject to criticisms of that kind, and yet have secured a most valuable monopoly. The result would have been that, while the patentees would have acquired for themselves the best of the ground definitely ascertained to be covered by the discovery, it would have been possible for others to make use of the principle of the discovery outside of that area; but the patentees had not done that. Whatever their reason, it seemed to him that they had, in effect, claimed the sole right comprised in the principle, and had sought to prevent any other competitors from availing themselves to any great extent of the principle and had failed to define or limit the ambit of their claim, with the result that the patent was bad. The action was, therefore, dismissed with costs.

His Lordship granted a stay with a view to an appeal.

Commercial Topics.

Translation of Catalogues into Spanish.

H.M. Commercial Secretary at Santiago calls attention to the fact that several catalogues of British manufactures and books of British industries printed in the Spanish language and sent to Chile have been translated into incorrect Spanish. The question is an important one for engineers, and firms and trade associations who go to the expense of issuing publications in Spanish should endeavour to see that efficient translators are employed.

* * * *

Protection of Australian Manufacturers.

The Commonwealth Government is keenly interested in the development of local manufactures and in starting new industries, &c. The products of most of these new works are protected by a high tariff, but where this is not so other steps are taken to protect and develop them. This is strikingly exemplified by the steps recently taken to protect the carbide industry. The Commonwealth Government issued a proclamation under the Customs Act prohibiting the importation of calcium carbide, except under licence from the Minister of Trade and Customs. There is no duty on carbide under the existing tariff, but the manufacture of carbide having been begun in Tasmania, the Government undertook the responsibility of giving the manufacturers complete protection. Importations from abroad are not to be permitted until the whole of the Australian output has been absorbed. At present the consumption of carbide in Australia is about 15,000 tons per annum; the production in Tasmania is only about 5,000 tons, but it is intended to enlarge the existing plants to a capacity of 10,000 tons per annum.

* * * *

Tramway and Electric Supply Charges.

The Tramways (Temporary Increase of Charges) Bill, which has been introduced into the House of Commons by Sir Eric Geddes, should bring some relief to tramway undertakings. The Bill, which is only intended as a temporary measure, and will only operate until Feb. 15, 1923, proposes to modify certain limitations of the Statutory Undertakings (Temporary Increase of Charges) Act, 1918. Altered circumstances have rendered the latter Act unduly restrictive. Under the 1918 Act, local authorities cannot increase the statutory maximum charges by more than 50 per cent., and companies are prevented from declaring dividends on ordinary capital exceeding three-fourths of the pre-war dividends. The new Bill will enable such charges to be made by local authorities "as shall enable the undertaking to be carried on without loss," and, in the case of companies, to provide for interest on loan capital and "a reasonable return on share capital." Orders authorising the alteration of statutory charges may be made by the Minister of Transport, who may impose obligations as to the frequency and efficiency of any tram service. In cases of urgency, interim Orders may be made to operate for six months increasing the statutory charges by 100 per cent., subject to revision by an Advisory Committee upon justifiable local representations.

We are pleased to see that the irksome restrictions of the 1918 Act upon tramways undertakings are to be removed, but many of the electricity supply companies are also badly hit by the Act. For instance, at the recent meeting of the Scarborough Electric Supply Company, it was stated that the proposed dividend of 2¼ per cent. was the maximum allowed, and Mr. A. A. Campbell Swinton, the managing director, pointed out that if they earned much more than sufficient to pay the dividend the Electricity Commissioners would tell them they must reduce their prices. Unless this policy is quickly altered, it will kill electrical enterprise in this country. The demand of electric supply companies for authority to increase their charges so as to give a fair return upon the capital invested is a just one, and we hope that the company, as well as Edmundsons Electricity Corporation, which is supplying 35 provincial towns, and other companies in a similarly unfortunate position, will be successful in getting the desired powers.

Personal and Appointments.

Mr. G. H. Ashdown, C.B.E., Director of Stores, Admiralty, will retire on May 31, and will be succeeded by Mr. J. W. L. Oliver, O.B.E., acting as Senior Deputy Director.

Mr. J. F. Dixon has been appointed manager of the Mansfield & District Tramways Company, in succession to Mr. C. R. Tattam, who is taking up an appointment with Messrs. Balfour, Beatty & Company.

Mr. James R. Lilleker, chief assistant and deputy electrical engineer of the Rotherham Corporation Electricity Works, has resigned in order to accept a position as manager of a manufacturing firm in the Midlands.

Another presentation has been made to Mr. William W. Lackie on his appointment as an Electricity Commissioner. Last week the chief municipal officials of Glasgow through Sir John Lindsay, the town clerk, presented him with a silver tea service and a silver cigarette box.

Mr. J. W. Thomas, B.Sc., A.M.I.E.E., has resigned his position as instructor in electrical engineering at the Birmingham Municipal Technical College to take up the post of Assistant General Secretary to the E.P.E.A., and future communications for him should be addressed to the E.P.E.A. offices, 65-66, Chancery-lane, London, W.C.2.

Out of the applicants for the position of electrical engineer and manager to the PETERBOROUGH Corporation the following have been selected for interview by the Council on the 12th inst.: Mr. J. B. Hudson, borough electrical engineer, Leigh, Lancs.; Mr. F. H. Rudd, borough electrical engineer and manager, Rochdale; Mr. J. W. Spark, borough electrical engineer, West Hartlepool; Mr. C. M. Shaw, city electrical engineer, Worcester; Mr. W. G. Turner, chief assistant engineer, Newcastle and District Electric Lighting Company; and Mr. W. Yorke, chief electrical engineer to Spondon (Derby) Electric Power Scheme.

Electricity Supply.

Mr. J. M. M. Munro, consulting engineer, of Edinburgh, has been appointed by the Town Council of BO'NESS to advise regarding the proposed extension of the electricity works.

As a protest against the non-provision of ELECTRIC LAMPS in the MINE, which miners claim give more safety and a better light below ground, 1,400 men employed at the Tirpentwys Colliery, Pontypool, have given a fortnight's notice to cease work.

It has been decided to install additional generating plant at the DOVER Electricity Works at a cost of £30,000. The Electricity Commissioners are desirous that the Corporation should erect a new station at the pier end of the town in order to supply electricity to Deal, Folkestone and Canterbury, but the estimated expenditure of £150,000 is considered too much at present.

COVENTRY Corporation has purchased about 50 acres of land at Hawkesbury, four miles from the city, for the erection of a new generating station. The demand for electric power expanded rapidly during the war, and the new station is well placed for railway, canal, main roads and coal supply. It will take 3 years to equip and when ready to supply the existing station will be used as an auxiliary station.

DUNDEE Electricity Committee has adopted a scheme of the city electrical engineer (Mr. H. Richardson) to install additional machinery, including two 5,000 kw. turbo-generators and boilers, at the Carolina Port generating station, at an estimated cost of £189,000. A large extension scheme is in course of evolution, and the present extensions are of a temporary character, in order to meet the increasing demands for energy for power and lighting.

Hitherto ten small street refuges at important traffic junctions in HAMMERSMITH have been illuminated by oil lamps at a cost of £208 a year, but the boro' electrical engineer (Mr. G. G. Bell) has recently installed electric bulkhead ruby lights at a cost of £3 10s. each. The annual cost of current and maintenance will be £25, so that a saving of £147 for the first year and £182 per year afterwards will be effected. The Council has agreed to supply electric current to the "White City" at 6d. a unit from sunset to 11 p.m., and at 1½d. per unit, plus 50 per cent. during the remainder of the 24 hours. A supply main is to be laid to Messrs. Buckland & Sons' Works at a cost of £2,174 as an annual payment of £500 for power has been guaranteed.

At a meeting of the HOME COUNTIES (No. 9) AREA JOINT INDUSTRIAL COUNCIL FOR THE ELECTRICITY SUPPLY INDUSTRY on March 31 the application from the Trades Unions represented for further advance in wages was considered. It was felt that the question was contingent on the fixing of basic rates, but in order that something might be done in the meantime to meet the case, it was resolved to grant an advance of 3s. per week to all employees of electricity supply undertakings in the area as from the 1st inst., and that if basic rates are not fixed before June 1 a further increase of 3s. per week be paid as from the latter date. Meetings will be held as early as possible to fix the basic rates, and when these are fixed they will be operative as from Feb. 1, 1920. The various electricity supply undertakings in the area are, therefore, earnestly recommended to adopt the increase mentioned above.

Electric Traction.

As the LANARK County Council has declined to purchase the undertaking of the Lanarkshire Tramway Company at present, the latter has to purchase the Council's lines at a cost of about £61,000.

As the result of a collision between two MIDDLESEX tramcars on Monday afternoon, 14 persons were injured. The accident was due to a car, which was descending the steep incline from the Alexandra Palace to the road, getting out of control and crashing into a stationary car outside the entrance gates.

The LONDON COUNTY COUNCIL have decided to introduce reduced fares on the long-distance routes between 10 a.m. and 4 p.m. This concession, which is to apply from Monday to Fridays inclusive (and not on Christmas Day, Good Friday or Bank Holidays), will take the form of a maximum charge of 2d. for any distance over the 1d. fare stage, which is on the average 1·2 miles long. The total receipts of the Council's tramways department for the financial year ended March 31 amounted to £4,157,311, compared with £3,479,287 for the previous year.

The report of the inspector of the Ministry of Transport (Major Hall), who investigated the accident which occurred in January last on the system of the YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS COMPANY, states that during a heavy snowstorm a large number of overhead telegraph and telephone wires were blown down at Wakefield, and at least two of them came into contact with the tramway trolley wire underneath. A railway goods guard had his feet entangled in the free end of the broken wire, and received a severe shock, while his mate, a man named Riley, who went to his assistance, was killed by the shock which he received. Guard wiring was entirely deficient, and the company explained that this could be accounted for by the extreme difficulty in obtaining material during the war, and the fact that their staff were continuously employed on other deferred repairs. Major Hall, while giving every consideration to these reasons, thinks that the company cannot be entirely freed from responsibility, mainly in view of the fact that nearly a year had elapsed since a delivery of the necessary wire was made. There are many directions, he adds, in which partial solutions have been tried, and are in use elsewhere, as for example non-fouling trolley heads, slipper type collectors, boom stops, check ropes, &c., none of which appears to be in use on the company's system.

Institution Notes.

A lecture on "Electric Driving of Textile Mills" was recently delivered by Mr. Edwin Preece before the Bradford Textile Society.

Nominations for Chairman, Vice-Chairman and Committee of the North-Western Students' Centre of the Institution of Electrical Engineers should be sent to the hon. secretary, Miss Madeline Nott, 8, Moreton-avenue, Stretford, Manchester, before April 12.

An interesting Paper on "Electric Welding" was recently read before the National Association of Supervising Electricians by Mr. T. F. Tate. The description of recent developments in this special subject and the practical information condensed within the limits of the Paper were highly appreciated by the members present.

At the recent annual general meeting of the Chemical Society the following officers were elected for the ensuing year: President, Sir James J. Dobbie; vice-presidents, Prof. J. B. Cohen, Prof. F. G. Donnan, Dr. H. J. H. Fenton, Prof. S. Smiles, Prof. J. Walker and Prof. W. P. Wynne; treasurer, Dr. M. O. Forster; secretaries, Dr. J. C. Philip and Dr. H. R. Le Sueur; foreign secretary, Dr. A. W. Crossley.

At a meeting of the West of Scotland Branch of the Association of Mining Electrical Engineers, Mr. A. B. Muirhead contended that with the use of low grade fuel, or unsaleable coal at collieries, cheaper electrical power could be generated than by super-power stations. He claimed that the equipment of collieries with up-to-date machinery compared favourably with any other industry in the world.

On Tuesday next at 3 p.m., Major G. W. C. Kaye delivers the first of two lectures at the Royal Institution on "Recent Advances in X-Ray Work"; on Thursday (April 15) Mr. S. Skinner commences a course of two lectures on "New Experimental Studies in the Liquid State," and on Saturday (April 17) Prof. W. H. Eccles commences a course of two lectures on "The Thermionic Vacuum Tube." The Friday Evening Discourse on April 16 will be delivered by Prof. J. A. McClelland on "Ions and Nuclei."

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Great George-street, London, S.W.1, on Thursday and Friday, May 6 and 7. On the opening day the Council will present their annual report, and the retiring president, Mr. Eugene Schneider, will induct into the chair the President-Elect, Dr. J. E. Stead, F.R.S. The Bessemer gold medal for 1920 will be presented to Mr. Harry Brearley and the award of the gold medal and the freedom of the Blacksmiths' Company will be announced. The President will then deliver his inaugural address. During the remainder of the morning session and in the afternoon session a selection of Papers will be read and discussed. In the evening the annual dinner will be held in the Connaught Rooms, Great Queen-street. The meeting will be continued on Friday morning and in the afternoon. Among the Papers to be read and discussed will be the following: "Direct Current compared with Three-Phase Current for Driving Steel Works Plant," by Mr. C. A. Ablett, and "Some Defects in Electrode Deposited Iron," by Mr. W. E. Hughes.

Miscellaneous.

In reply to a question by Capt. Wedgwood Benn in the House of Commons last week, Mr. Bridgeman stated that there were now no restrictions on the importation of electric light bulbs from any source.

At Spennymoor (Durham) on the 23rd ult., the Weardale Steel, Coal & Coke Company were fined £50 for insufficiently protecting electric wires at their by-product ovens, Tudhoe Works, whereby George Copeland met his death on Feb. 1 by coming in contact with a live wire. Wm. Shand, electrical engineer for the company, said the wire was put up in the ordinary way and there was no cradle underneath. The wires had been in the same condition for 12 years and no complaint had been made until the accident occurred.

We learn that such striking results have been obtained by the new Long-distance Marconi Wireless sets on board the Cunarders "Imperator," "Mauretania" and "Carmania" that a rapid extension of these instruments to other great liners may be expected. The White Star liners "Olympic," "Adriatic," "Baltic," "Celtic," "Cedric" and "Megantic" are being similarly equipped, and will carry the new apparatus on their next sailings from England. All these ships will now have direct inter-communication with land over a distance of 1,400 miles. Radiotelegrams may be handed in at any Post Office, but the word "Aberdeen" must be included in the address after the name of the ship. The charge is 10½d. per word.

At last week's sitting of the Royal Commission on Awards to Inventors, the Chloride Electrical Storage Company claimed a royalty of 6d. for each of their improvements to electric accumulators supplied to the Ministry of Munitions through four accumulator firms on the ground that the Ministry had advised the claimants that they would be responsible for royalty payments. The claim covered the sale of 53,000 improvements, against the Ministry's figure of 18,000. After hearing claimants' statement, Mr. Justice Sargant suggested that the Company and the Ministry representatives should go into the figures, and if they could come to an agreement he thought the royalty for expenses on each accumulator supplied was not unreasonable.

Bankruptcies and Liquidations.

The discharge of Wm. Hy. Howard (lately trading as the Holborn Electrical Company), 5, Featherstone-buildings, Holborn, London, E.C., is suspended for two years ending Feb. 27, 1922.

It is proposed to wind up the Spanish & General Wireless Trust, Ltd., voluntarily, and to form a new company, to be named the Spanish & General Corporation, Ltd.

Tenders Invited and Accepted.

Dunedin (N.Z.) Council require tenders by April 26 for electric car bodies, car trucks and equipment. Specifications from the Town Clerk.

Tenders are invited for electric wiring and fitting of the Tydraw Workmen's Institute, Tynewydd, Treherbert. Tenders by April 13 to the Secretary.

Leith Corporation want tenders by April 13 for one year's supply of overhead electrical and car fittings, insulated wire, &c. Schedules, &c. from the Burgh Surveyor.

Manchester Electricity Committee want tenders by April 14 for a 10-ton overhead hand-power travelling crane. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Glasgow Corporation require tenders by April 14 for wiring and fitting work in the extension of the Knightswood Hospital. Specifications from the office of Public Works, 64, Cochrane-street, Glasgow.

Bedwelty Urban Council require tenders by April 12 for electric light wiring and fittings at Pengam and Aberbargoed. Specifications from the Clerk, High-street, Bargoed, or Mr. R. H. Fletcher, Cardiff.

Glasgow Corporation require tenders by April 12 for wiring and fitting work in connection with the Gilshockill area housing scheme. Schedules and forms of tender from the Electrical Engineer, 75, Waterloo-street.

Canterbury Corporation invite tenders for one 1,000 kw. three-phase turbo-alternator and surface condenser two rotary converters and a superheater. Specifications from Messrs. May & Hawes, 36, Victoria-street, S.W.1, and tenders to Town Clerk by 4 p.m., April 19.

Tenders are invited for the supply of about 55 tons of hard-drawn electrolytic copper wire for two municipal electricity works in the Trondhjem (Norway) district. Tenders to Prof. O. S. Bragstad, Trondhjem, by April 15.

Cardiff Corporation invite tenders for the supply and erection of a 5,000 kw. turbo-alternator and surface condensing plant. Specifications and forms of tender from the Electrical Engineer, The Hayes, Cardiff, and tenders to the Town Clerk by April 29.

Tenders are invited up to May 5 for supply and delivery to the Postmaster-General's Department, State of Western Australia of insulators, bolts, brackets, &c. Specifications from the Commonwealth Offices, Room 406, Australia House, Strand, London, W.C. 2.

Yarmouth Corporation require tenders by April 16 for a 2,000 kw. turbo-alternator, a 750 kw. rotary converter and transformer and a 750 kw. frequency charger. Specifications from Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, Westminster, S.W.1.

Sunderland Corporation invite tenders for two water-tube boilers, with integral superheaters, mechanical stokers, vertical c.i. tube economisers, one 1,000 kw. rotary converter, &c. Specifications from Mr. A. S. Blackman, and tenders to Town Clerk by April 28.

The Ministry of Communications (Director of Telegraphs and Telephones), Athens, require tenders by May 13 for supply of wooden poles, galvanised and brass wire, insulators, telephone cables, exchange equipment, &c. Specifications from the Ministry of Communications.

The Agent-General for Western Australia invites tenders for one 7,500 kw. turbo-alternator and condensing plant for the Perth power station. Specifications and tender forms from the consulting engineers (Messrs. Merz & McLellan), 32, Victoria-street, London, S.W.1, and tender forms may also be obtained from the Agent-General, to whom tenders are to be addressed at Savoy House, Strand, London, W.C.2, by noon May 14.

Hackney (London) Borough Council is recommended to accept the tender of British Insulated and Helsby Cables, Ltd., for e.h.t. cables at £17,002.

Stepney (London) Borough Council received eight tenders from seven firms for the supply of switchgear for the Whitechapel and Mile End-road sub-stations, and the lowest, that of A. Reyrolle & Company (at £7,760 10s.), has been accepted. The highest tender was £9,910. The Council has also placed orders with the British Mannesmann Tube Company for 24 steel tubular electric standards at £14 5s. 3d. each; with W. T. Henley's Telegraph Works Company for 2¼ miles of cable (at £4,349) and for house service cable at £385; and with Sutton & Company for 1¼ mile of earthenware pipes and ½ mile of troughs and covers at £215 5s. 4d

Business Items, &c.

We have received from the Hackbridge Cable Company, Ltd., their monthly desk calendar for April.

Fredk. Geo. Burton and Reg. Boardley (trading as the Victor Engineering & Supply Company), electrical engineers and contractors, 17, Lloyd-street, Manchester, have dissolved partnership. Debts by Mr. Boardley, who continues the business under the same style and at the same address.

The Automatic & Electric Furnaces, Ltd., have appointed Messrs. F. Hiorth & Sons, Josefinegade 13, Christiania, Norway, agents for Wild-Barfield electric furnaces for Norway and Denmark. A furnace will be erected at the above address, where demonstrations will be given to those who are interested in the automatic steel hardening process.

In a well-illustrated pamphlet on the efficient lighting of shop windows and interiors Messrs. Holoplane Ltd., give some particulars, with prices of Holophane reflectors and bowls, excellite glassware, &c. Efficient lighting is essential to good salesmanship, and by the use of Holophane reflectors the best and most economical results are obtained

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1914 Specification.

11.657 Marguerond & Du Roussett. Indicating arrangements for electricity supply systems. (12 5 14.)

1916 Specifications.

138.368 Tucker. Microphones. (15 9 16. Complete accepted. 22 5 17; patent sealed 22 5 17.)

138 940 Clerget & Soc. Clerget Blin et Cie. Connection for electric leads. (24 11 16.)

1917 Specification.

112.264 Siemens & Halske Akt.-Ges. Electric incandescent lamps. (29/12 16.)

1918 Specifications.

120 899 Dixt n. Telegraphy. (1 11 17)

138.377 Henley's Telegraph Works Co. & Grover. Distribution of electrical energy. (12 8 18.)

Each main conductor is divided into a plurality of subsidiary conductors, whereof the innermost subsidiary conductor of each main conductor is run at the full voltage of the system, whilst the remaining subsidiary conductor (or conductors) is (or are) arranged concentrically or externally relatively to the innermost conductor, and is or are operated at relatively lower voltages, which decrease in the order of the distance of the respective conductors from the innermost conductor.

138.383 Latour. Automatic alarm devices for use with vacuum tube relays. (4 10 17.)

1919 Specifications.

124.211 Fery Electric storage cells. (30/4 17.)

127.826 Meunier. Electric heaters for ironing, cooking, heating and like apparatus (4 6 18.)

129.254 Benjamin Electric Ltd. Electric switches. (3 7 18.)

129.621 Lundberg & Nath rst. Apparatus for discovering and determining electrically the location of veins of ore or mineral. (18 7 18.)

129.653 Dechelle. Electric lighters. (12 7 18.)

130.996 Pattay & Jaquemot. Magneto-electric pocket lamp. (7 8 18.)

133.678 Anzani. Contact-breakers for high-tension magnetos. (9 10 18.)

133.715 Russ & Russ. Electrical driving means for phonographs or the like. (1 9 17.)

133.967 Courtiade. Regulators for dynamo-electric machines. (18/7/16.)

134.812 Automatic Telephone Mfg. Co. Automatic or semi-automatic telephone systems. (4 11 18.)

136.817 Hulfish. Automatic telephone systems. (8 12 17. Divided application on 121.471.)

136.848 Rosengart. Magneto-electric lighting sets for cycles and the like. (21/12 18.)

138.406 Matheson. Electrolytic cells. (23 1 19.)

138.430 Gatrill. Apparatus for indicating the amount of electric current passing through a network box link, and the like. (13 2 19.)

138.439 Illingworth. Electrical cut-outs or circuit-breakers. (18/2/19.)

138.441 Brecknell, Munro & Rogers & Willis. Method of and means for connecting span wires and fittings for the suspension of conductor or trolley wires in overhead wire systems of electric traction. (20 2 19.)

138.447 Harrison & Eyre. Fittings for electric and other lamps. (26/2/19.)

138.488 Ivey & Salisbury. Drain devices for electric storage batteries. (4 4/19.)

138,530 Jackson & Mellersh. (International Callophone Corpn.) Telephone systems. (27 5 19.)

138,539 Lutz. Electric insulators. (11/6 19.)

138,544 Siemens Bros. & Co. & Pettigrew. Telephone exchanges. (2 7 19.)

138,548 Marks. (Spardon Electrical Products Co.) Fire detectors. (9 7 19.)

138,558 Phillips & Lea. Shades or reflectors for electric lamps. (2 8/19.)

138,559 Stewart & Penman. Electric fusible cut-outs. (5 8 19.)

138,675 B.T.-H. Co. & Wilson. Protective gear for alternating electric current generators. (18/11/9.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

November 20, 1919.

28.807 Clay & Eccles. Telephone transmitters and receivers.

28.812 Cooper. Telephone ringing contacts.

28.820 Brunot & Chateau. Electro-generator sets.

28.840 Cohen. Duplex cable signalling. (27 5 19, U.S.)

28.844 Hansen. Wireless transmission of energy. (7/9/15, U.S.)

28.845 Ashcroft. Electrolytic apparatus.

28.854 Mackley. Bayonet joint sockets of electric lamp-holders, &c.

28.856 B.T.-H. Co. & Trechman. Protective devices for a.c. distribution systems.

28.864 Berwick & Co. & Sizaire. Electrical conductors.

28.872 Chamberlain & Hookham & James. Electricity meters.

28.873 Chamberlain & Hookham & James. Interrupting devices for electric circuits.

28.880 Rogers. Wireless signalling system.

28.882 Waygood-Otis, Ltd. (Otis Elevator Co.) Switchboard apparatus.

28.889 Sperry Gyroscope Co. Arc lamps. (20 11 18, U.S.)

28.893 Fairburn. Controllers for electric motors.

November 21, 1919.

28.935 Kitchingman. Leads for arc lamps.

28.940 Smith. Electric warmers.

28,944 Automatic Telephone Mfg. Co., Smith & Harrison. Telegraph printing systems.

28.949 Norton. Combined electric incandescent or glow lamp-holders and switches.

28.975 B.T.-H. Co., Warren & Young. Magneto-electric machines.

29.022 Kimber. Electric irons.

29.029 Etchspare & Kornfeld. Watertight electric light fittings.

29.033 British Ever-Ready Co. & Westney. Electric switches.

November 22, 1919.

29.078 Cooper. Disinfecting telephone instruments.

29.084 Scott-Taggart. Thermionic devices.

29 098 Hayes-Gratze. Current detectors in connection with electric ignition of engines.

29.124 Coombs & Jenks. Switches.

29.141 Dowsett. Thermionic devices.

November 24.

29.186 Anderson. Controlling electric motors operating pressure pumps, &c.

29.207 Curtiss's & Harvey & Brisc e & Cunningham. Filaments for electric lamps.

29 253 Dakin & Norris. Electric motors.

29.276 Jensen. Arc lamp resistance for kinematographs, &c.

29.280 Merz & McLellan & Redman. Conductor rails for electric railways, &c.

29.284 Jane. Automatic interrupters for electrical circuits. (29 3 16, Spain.)

29.295 Chandler. Wireless receiving apparatus.

29.300 Gale. Incandescent welding by electricity.

November 25.

29.322 Muirhead & Heurtley. Telegraphy.

29.336 Turnock. Electrically heated articles.

29.339 Turner. Electric ignition, collecting, &c., devices.

29.392 B. T. H. Co. (G. E. Co.) Wireless signalling systems.

29.395 Watson. Magneto-electric machines.

29.400 Metropolitan Vickers Electrical Co. Condensers.

29.404 Park Royal Engineering Works & Joyce. Switches.

29.414 Ericksen. Electric furnaces.

29.538 Dicorat. Electrically driven motor vehicles. (27 11 18, France.)

Companies' Reports, &c.

The **Beauly Electric Supply Company, Ltd.**, is paying a 5 per cent. dividend.

The directors of the **British Ever-Ready Company, Ltd.**, have declared a dividend of 15 per cent. on the ordinary shares.

The **Submarine Cables' Trust** notify that the coupons due on the 15th inst. will be paid by Messrs. Glyn, Mills & Company, 67, Lombard-street, E.C.2.

At the annual meeting of the **Dictograph Telephones, Ltd.**, a dividend of 15 per cent. on the ordinary shares was declared, and also 3s. 6d. per share on the deferred shares. A sum of £4,021 was carried forward.

The directors of **Sir W. G. Armstrong, Whitworth & Company, Ltd.**, have declared a dividend on the ordinary shares for the half-year ended Dec. 31 of 1s. 6d. per share, making 2s. 6d. per share for the year.

The directors of the **Anglo-American Telegraph Company, Ltd.**, have declared an interim dividend for the quarter ended March 31 of 15s. per cent. on the ordinary and £1 10s. per cent. on the preferred stock.

The profit of the **Hongkong Tramway Company, Ltd.**, for 1919 amounted to £38,134, and with amount brought forward the total is £39,616. The directors recommend a final dividend of 1s. 3d. per share, making 2s. per share for the year, leaving to be carried forward £7,116.

After setting aside £10,000 for depreciation and making provision for excess profits duty, a dividend is recommended for 1919 on the deferred shares af 2s. and a bonus of 6d. per share by the directors of **Stewarts & Lloyds, Ltd.** A sum of £100,000 is placed to reserve, £70,000 to employee's benefit reserve and £100,000 carried forward.

At the general meeting of the **Slough & Datchet Electric Supply Company, Ltd.**, a resolution was adopted to increase the capital by the creation of 50,000 7½ per cent. cumulative preference shares of £1 each, of which 35,000 are to be offered to shareholders. A dividend of 5 per cent. was declared for the past year. A sum of £2,500 was placed to depreciation and reserve and £1,230 carried forward.

The accounts of the **Isle of Wight Electric Light & Power Company, Ltd.**, for 1919 show a profit of £12,128, and, including £655 brought forward, £13,083 is available. After providing £5,500 for interest and sinking fund on debentures, the directors recommend that £600 be allocated to writing down investments, £6,500 placed to renewal fund, and £483 carried forward.

At the annual meeting of the **Newcastle Emlyn & District Electric Supply Company, Ltd.**, Capt. W. Lewes, J.P., and Mr. Evan Rees were added to the board, and a dividend of 6 per cent. was declared for the year 1918. The revenue from the supply of current showed an increase of 20 per cent. The engineer was instructed to prepare a scheme for extensions of plant to meet the demand for power.

After providing for debenture interest, &c., the net profit of **Browett, Lindley & Company, Ltd.**, for 1919 was £20,891. With £10,593 brought forward, the disposable balance is £31,484. The directors propose a further dividend on the preference shares of 9 per cent. on account of arrears, and a dividend of 8 per cent. and a bonus of 4 per cent. on the ordinary shares (making 12 per cent. for year), leaving £19,484 to be carried forward.

The gross receipts of the **London United Tramways, Ltd.**, for 1919 amounted to £496,542, an increase of £134,115 compared with 1918, but owing to continued advances in the cost of labour, &c., working expenses increased by £122,855 to £496,687. As a result there is an adverse balance of £145. After charging debenture and loan interest for the year and bringing into the account the debenture interest for 1918 (paid in May, 1919) the total deficiency to be carried forward to 1920 is £71,578.

During 1919 the connections to the mains of the **Bromley (Kent) Electric Light and Power Company, Ltd.**, increased from 4,854 to 5,111 kw. The gross profit was £10,479, compared with £7,744 in 1918, and after payment of debenture interest and trustees' fees, &c. (£2,937), and adding £1,404 brought forward, the balance is £8,946. The directors recommend payment of a dividend at rate of 4 per cent. for year, that £4,500 be placed to reserve, leaving £1,446 to be carried forward.

The directors of **Electro-Bleach & By-Products, Ltd.**, have declared further interim dividends on account of 1919 of 3½ per cent. on the preference shares (making 7 per cent. for year) and of 7¾ per cent. (less tax) on the ordinary shares, making 14 per cent. for the year. The directors have accepted an offer from Messrs. Brunner, Mond & Company, Ltd., to purchase all their preference and ordinary shares. It is proposed to exchange for every two Electro-Bleach preference shares one Brunner, Mond ordinary share and 8s. in cash, and for every two Electro-Bleach ordinary shares one Brunner, Mond ordinary share and 3s. in cash.

The total revenue of the **South Metropolitan Electric Tramways and Lighting Company, Ltd.**, for 1919 was £115,303. The expenses increased from £73,305 in 1918 to £92,892, the net profit was £22,264, and after adding balance brought forward and setting aside £7,500 to renewals fund the surplus is £16,681, compared with £22,178. The directors have placed £5,000 to reserve, and after paying the preference dividend a balance of £1,507 was carried forward. Gross receipts from electricity supply section of undertaking (including amount represented by sale of energy to tramways) amounted to £26,771, compared with £22,783.

Mr. F. C. Gardiner, who presided over the annual meeting of the **Clyde Valley Electrical Power Company** on Thursday last, stated that the trading profit for the past year showed a reduction from that of 1918, due to the closing down of munition work; but the latter portion of the year showed considerable improvement. The output since the close of the year showed continued improvement, and the prospects for the current year were good. In view of the adverse conditions so far as cost of labour and material were concerned, the result of the past year's trading was most satisfactory. Contracts for supply showed an increase during the year of 14,442 H.P., and connections to mains an increase of 11,217 H.P.

The profit of the CAMBRIDGE ELECTRIC SUPPLY COMPANY, LTD., for 1919 was £8,657, and with £2,552 brought forward the total is £11,209. After deducting debenture and other interest and placing £2,500 to depreciation, the balance is £6,842. The directors recommend payment of a dividend of 5 per cent. for the year, leaving £2,382 to carry forward. In order to meet expenditure on further extensions of mains, &c., it is proposed to call up the remaining £1 per share on the 9911 shares aready issued and to raise £10,000 by the issue of debentures for 10 years carrying interest at 7½ per cent. per annum. Mr. R. F. Scott succeeds Mr. D. Munsey as chairman and Mr. R. C. Pierce has been elected to fill the vacancy caused by the retirement of Mr. Munsey.

Mr. Geo. Alderson Smith, who presided over the meeting of the SCARBOROUGH ELECTRIC SUPPLY COMPANY, LTD., on the 30th ult., said that the proposed dividend of 2½ per cent. was the maximum allowed. Mr. A. A. Campbell Swinton, managing director, pointed out that if they earned much more than sufficient to pay the dividend the Electricity Commissioners would tell them they must reduce their prices. That policy would bring all electrical enterprise to an end. They could not raise money for extensions if it was only going to get 2½ per cent. Edmundson's Electricity Corporation supplying, 35 towns, were promoting a special Act of Parliament to increase their prices and get themselves out of the difficulty. Sir Charles Parsons was re-elected a director, and Mr. F. G. Holden, the engineer and manager, was also added to the board.

Addressing the shareholders of the LIVERPOOL DISTRICT LIGHTING COMPANY, LTD., last week, the chairman (Mr. Charles McLaren) stated that the sales of current during 1919 increased very considerably and were still increasing. 128 new consumers were connected, and many more might have been added had it been possible to get the necessary cable and meters. The new business already obtained this year was estimated to consume 100,000 units per annum, and their only difficulty was getting cable and meters to enable them to give the supply. It was proposed to lay a new main cable to Seaforth to deal with the growing demand in that part. The profit had increased from £2,469 in 1918 to £5,841, due to the increased number of units sold and the increased price. They were paying a dividend at the rate of 5 per cent. per annum, and placing £1,000 to reserve.

The profit of the WASTE HEAT AND GAS ELECTRICAL GENERATING STATIONS, LTD., for the year ended Jan. 31, 1920, was £39,626 (against £38,646 in previous year). Deducting £13,500 transferred to reserve and adding amount brought forward the profit available is £43,464, the directors recommend that a dividend be declared at the rate of 8 per cent. for the year, leaving a balance to be carried forward of £17,864. There has been considerable delay in the delivery of the plant for the new power-station at Horden, and it is not expected that it will be completed and ready for operation until the middle of this year. The new generating plant at Weardale has been run satisfactorily, but it is not yet in continuous operation. Capital expenditure during the year amounted to £45,039 14s. 6d., mainly in connection with the new power-station at Horden.

The holders of the obligations of the CONSTANTINOPLE TELEPHONE COMPANY have adopted a scheme for discharging the arrears of interest, which has not been paid since July 1, 1914. The arrears are to be met by the issue of certificates for £20, bearing interest at 6 per cent. per annum, the balance of £1 to be paid in cash. The date for the payment of the principal sum of the obligations has been deferred for five years—to June 30, 1934. It is also proposed to deal with the pre-war indebtedness to contractors and others in the same manner. The president (Sir Alex. Roger) stated that when they secured re-possession of the property a modification of their concession was granted for the time being by the Turkish Government in view of the altered circumstances and the increased cost of working. As a result the earning power had been improved, and they had every reason to believe that, unless anything unforeseen happened, they should be in a position to pay the interest on the obligations and the certificates.

The gross profit of the MADRAS ELECTRIC TRAMWAYS (1904), LTD., for 1919 was £33,839, 10s. 7d. After debiting interest and London office expenses, making provision for debenture stock sinking fund and transferring £12,000 to depreciation, the balance is £14,705. With £4,820 from 1918 the total is £19,525. Deducting the dividends on the preference shares, and the interim dividend of 4 per cent. on the ordinary shares, the balance is £11,234. The directors recommend payment of a further dividend of 4 per cent. on the ordinary shares, making 8 per cent. for the year, the contribution of £1,000 to a gratuity fund for the employees in Madras, and the transfer to general reserve of £3,000, leaving to be carried forward £4,944. Wages and the cost of materials have continued to advance, revisions in fares were made during the year, but these have only partially met the enhanced cost of running.

The accounts of W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LTD., for 1919 show a profit of £203,368, and after deducting directors' and auditors' fees, debenture interest and amount written off for depreciation on buildings and machinery (£34,743), and adding £122,009 from 1918, the total is £290,634. Deducting income tax (£45,458), amounts transferred to reserve (£20,000) and to account for depreciation of Government loans and trustee securities (£9,543), and paying the dividend on the preference shares (£9,000) and the interim dividend on the ordinary shares (£10,000), the available balance is £196,633. A sum of £5,000 has been placed to staff pension and deferred pay funds, and the directors recommend payment of a final dividend on the ordinary shares of 2s. 6d. per share, less tax (making 3s. for the year). This will require £50,000, and leave to be carried forward £141,633. Henley's Tyre & Rubber Company, the whole of the capital of which is held by the company, has had a successful year's trading, and the tyres manufactured, both pneumatic and solid, have secured a very high reputation. The directors record with regret the death of the Earl of Galloway, one of the directors.

Sir Robert Hadfield, Bart., who presided over the annual meeting of HADFIELD'S, LTD., on Monday, said that reconstruction appeared to present as many, if not more, difficulties than the conditions met with in wartime. The great trouble had been in securing the aid which might have been expected from their workers, for it was as much in their interests as in the interests of the employer to have continuous and increased production. The help rendered since the war was, however, anything but satisfactory. There had been much delay in the completion of their various new plants. The moulders' strike brought everything to a standstill, and consequently there had been unavoidable delays generally to industrial work. That meant seriously reduced output, for which the workers themselves had to pay the cost. It was decided to increase the capital of the company by £500,000 to enable the directors to carry into effect the agreement for an exchange of shares with Harper Bean, Ltd. It was reported that since the Harper Bean proposal was decided upon opportunity had arisen to acquire a block of 30,000 shares in John Baker & Company, of Rotherham.

The gross receipts of the SUNDERLAND DISTRICT ELECTRIC TRAMWAYS, LTD., exceeded those of 1918 by £12,963 (or 34·9 per cent.), and those of 1914 by 76 per cent. The rolling stock, cables and electrical equipment will have to be renewed and the car sheds and repairing shops enlarged. The chairman (Mr. H. R. Hogg) stated at the meeting last week that they would have to put themselves in the position of being able to carry 6,000,000 passengers annually, compared with 4½ millions six years ago. Their cars, which have not been able to be renewed during the war, must be gradually replaced at a cost of nearly £2,000 each, compared with £700 in pre-war days; the cost of current had been increased by nearly 100 per cent., and they were paying the staff large increases in salaries and wages. For the years 1912-1919, after deducting from the interest on investments a small amount for sinking fund on a portion of the capital, their total receipts were £311,192. 14s., and their working expenses for the same period (including power) were £189,000. 11s. 3d., or 60¾ per cent. of the receipts. Interest on debentures was £78,197 0s. 9d., leaving only £44,000 (14¼ per cent. of the whole) for reparations due to war-time work postponed. Therefore, unless the Board of Trade acted quickly in granting power to charge those who ride in the cars the present cost of their carriage the whole system must fall to pieces from natural decay. The rise in wages in November was hitting them badly, for although the gross receipts had increased in the interval (20 weeks) by £3,100 over last year's similar period, operating costs had gone up by £5,600. He said that last year's accounts, after providing its full share towards general reserve, showed sufficient to pay something on the preference shares, and the board proposed a dividend of 5 per cent. on their written down value (2½ on their original). That was the first money so apportioned in the 15 years of the company's working existence.

At an extraording general meeting of the BRITISH ALUMINIUM COMPANY, LTD., last week the resolution passed on March 15 to alter the articles of association, to increase the capital to £1,500,000 and to capitalise the reserves was confirmed. At the subsequent ordinary general meeting the chairman, Mr. A. W. Tait, said the demand was such that the company's works were now fully engaged in giving their maximum ouput. There was a healthy demand, not only in this country, but also abroad to meet the heavy requirements for the motor trade and for domestic utensils. They could foresee increasing demands in the motor, electrical and other industries, and those demands were at present largely in excess of pre-war requirements. The situation was a little obscure owing to the fact that the industry in France and in Switzerland was considerably handicapped at present by shortage of essential raw materials. The large works which were put up in Germany by certain manufacturing interests, with the assistance of the German Government, depended entirely upon electricity generated by means of brown coal or lignite, and it was not considered probable that those works could be continued economically in normal times.

The Government had laid considerable stress upon the necessity of developing the natural resources of this country, one of which was water-power, but the company could not usefully proceed further with their Lochaber water-power scheme until the policy of the Government with regard to hydro-electric development had been definitely settled. A Commission had been appointed to investigate the resources of the country in this respect, and a large amount of work had been done, but the final report had not yet been made. When this was issued and the Government had announced its policy, the company would then again carefully consider the position. As to the Orsieres power scheme in Switzerland, which was closed down during the war, work was recommenced during 1919, and it was hoped to complete the construction of the tunnels, intakes and penstock during this year. It was not intended to place orders for the construction of the pipe line or for the erection and equipment of the power house and factory, in hope that by the time that became necessary the situation on the Continent with regard to labour, materials and transport would have become more clearly defined than it is at present. Having dealt with the increased cost of operation and with the accounts of the past year, the report was adopted and a dividend at the rate of 10 per cent. for the year was declared.

New Companies.

DAVIES BROTHERS & DAVIES, LTD. (165,359).—Private company. Reg. March 17, capital £5,000 in £1 shares. To carry on the business of motor, mechanical, electrical, telephone and general engineers, manufacturers of and dealers in sparking plugs, &c. First directors are: F. R. Davies, E. F. Davies, C. H. Davies, O. T. Davies, R. Davies, J. G. Davies, E. T. Davies. Secretary: C. H. Davies, 46, Mansel-street, Swansea.

DICK, KERR & COMPANY, LTD. (165,546).—Private company; reg. March 22, capital £100 in £1 shares, to carry on the business of electrical and general engineers and contractors, &c. The subscribers are E. J. Alldis and G. Dickson, clerks. Reg. office, Queen's House, Kingsway, W.C.

ENGINEERING & LIGHTING EQUIPMENT COMPANY, LTD. (165,048).—Private company. Reg. March 10, capital £15,000 in £1 shares, to take over the business of electric and mechanical engineers and manufacturers carried on by Bird & Wells, and lately acquired by them from Engineering and Arc Lamps, Ltd. Permanent directors: W. Bird, G. J. Wells and S. A. Marples. Reg. office: Sphere Works, St. Albans.

FINTONA ELECTRIC LIGHT COMPANY, LTD. (4,918).—Private company. Reg. in Dublin, March 1, capital £4,000 in £1 shares, to carry on the business indicated by the title. First directors are: Dr. F. Bradley, J. Baxter, S. M. McCrae, H. F. Jones and J. F. Buchanan. Solicitors: Dickie and Carson, Omagh.

FLETCHER ELECTRO SALVAGE COMPANY, LTD. (164,150)—Private company. Reg. Feb. 17, capital £10,000 in £1 shares, to take over the business of electro depositors of metal carried on as Fletcher & Martin. Reg. office: 3, Penarth-street, Old Kent-road, London, S.E.

GREEN & SMITH, LTD. (165,002).—Private company. Reg. March 9, capital £15,000 in £1 shares, to take over the business of an electrical engineer and contractor carried on by J. D. Green as "Green & Smith." First directors are: J. D. Green and J. G. Craven. Reg. office: Albert Works, Meadow-lane, Leeds.

METAL TRADERS, LTD. (165,269).—Private company. Reg. March 15, capital £200,000 in £10 shares. To carry on the business of refiners of, dealers in and shippers and brokers of tin, zinc, copper, lead, aluminium, &c. First directors are: Sir Robert Balfour, Bart., K. Mathieson and A. E. Williamson. Reg. office: 7, Gracechurch-street, E.C.

A.C. SPARKING PLUG COMPANY, LTD. (164,741.)—Private company; reg. March 2, capital £20,000 in £1 shares, to acquire from the Champion Ignition Company (Flint, Michigan, U.S.A.) the concessions, patents, patent rights and trade marks of the A.C. sparking plug, and the business therein for certain countries.

VICKERS-HELVETIA, LTD. (165,529).—Private company; reg. March 20, capital £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in steel, iron, brass and metals, founders, electricians, electrical engineers, &c. First directors are Sir Francis H. Barker, S. V. Dardier, and H. Robinson. Reg. office, Vickers House, Broadway, Westminster.

WOODWARD, SONS & COMPANY, LTD. (11,051).—Private company: reg. March 18, capital £5,000 in £1 shares, to take over the business carried on by F. J. Woodward, electrical engineer and contractor. First directors are F. J. Woodward, J. O. Woodward (and secretary) and F. Woodward. Reg. office, 147, Renfield-street, Glasgow.

Prices of Metals, Chemicals, &c.

TUESDAY, April 7.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£114 0 0	—	—
Electro Wirebars...	,,	£114 0 0	—	£1 0 0
H.C. wire basis......	per lb.	1s. 3⅝d.	—	—
Sheet	,,	1s. 5$\frac{13}{16}$d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7⅝d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 11⅝d.	—	—
Sheet, basis	,,	1s. 4½d.	—	—
Wire, basis	,,	1s. 4d.	—	—
Iron—				
Cleveland Warrants	per ton	£10 7 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£47 0 0	—	—
Lead Pig—				
English	,,	£43 0 0	—	—
Foreign or colonial	,,	40 0 0	—	£0 5 0
Tin—Ingot	,,	355 0 0	£9 10 0	—
Wire, basis	per lb.	0 4 3½	—	1½d.

Salammoniac.—Per cwt. 105s.–160s.

Sulphur (Flowers).—Per ton £22.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £8 8s. 9d.

Copper Sulphate.—Per ton £48

Boric Acid (Crystals).—Per ton £74

Carbon Bisulphide.—Per ton £56

Sodium Bichromate.—Per lb. 9d

Sodium Chlorate—Per lb. 5½d.

Rubber.—Para fine, 2s. 4¼d.; plantation 1st. latex 2s. 3½d. per lb

Shellac.—T.N. Orange, 760s.

The rubber prices are supplied by W. T. Henley's Telegraph Works Co., Ltd.

Forty Years Ago.

(The Electrician, April 10, 1880.)

The Electro-Motor Telegraph.—Edison has sold his electro-motor telegraph to the Western Union for £20,000.

Dr. C. W. Siemens.—This distinguished electrician has been elected an honorary member of the American Institute of Mining Engineers.

"The Encyclopedia Britannica."—Sir William Thomson is writing the articles on pressure gauges and thermometry for the "Enclopedia Britannica."

The Victoria Docks.—We do not know how many tenders were sent in for lighting these docks by the electric light, or the amount of the various tenders, but we have heard that the amount of one tender was considerably over £30,000.

Society of Technical Engineers.—We are requested to mention that in consequence of the unavoidable absence of Dr. C. W. Siemens, his Paper "On the Application of the Dynamo Electric Current to the Fusion of Refractory Materials in Considerable Quantities," which it was stated by the President at the last meeting would be read on the 14th inst., is postponed until the 28th inst. The Papers to be read on the 14th are: 1. "Note on some Effects Produced by the Immersion of Iron and Steel Wire in Acidulated Water," by Prof. D. E. Hughes, member; 2. "Note on Prof. Hughes' Communication," by W. Chandler Roberts, Esq., F.R.S.; 3. "On the Adhesion of Metals Produced by Currents of Electricity," by Augustus Stroh.

Parody.—There seems to be a popular misapprehension about conversing through a telephone. It is not necessary to roar into the instrument so that you can be heard eight blocks away. The telephone don't work on that principle. If you are talking to a man, don't yell so as to disturb all peaceable citizens. Stand back 2 ft or 3 ft. from the mouth piece of the transmitter, and speak slowly and distinctly in your ordinary voice. The telephone is not deaf. Don't cry "hello" in bill-board type; rather whisper it in the minion.

> Do not saw the air too much with your
> Mouth, thus; but use all gently;
> For in the very torrent, tempest, and (as I may say)
> Whirlwind of your passion you must
> Acquire and beget a temperance
> That may give it smoothness.
> Oh, it offends me to the soul
> To hear a robustious, periweg-pated fellow
> Tear a telephone to tatters, to very
> Rags; to split the ears of the boys
> At the central office, who for the most part
> Are capable of nothing but inexplicable
> Dumb show and noise—especially noise.
> I would have such a fellow whipt
> For o'erdoing Termagant.
> It out-Herods Herod.
> Pray you avoid it.

(Picked up Adrift.)

The British Museum and the Electric Light.—On Saturday morning orders were received to remove all the lamps in the reading room of the British Museum and the approaches which have been used during the last three months in conveying the electric light and enabling readers to remain in the Museum library up to 7 p.m. During the month of April, therefore, the reading room will be closed at 6 o'clock every evening, to which hour the galleries will also remain open. The electric light has, however, been such an eminent success as an experiment that the temporary lamps will be substituted by permanent ones, and these will be extended to all parts of the Museum, so that during next winter the public can be admitted up to 6 or 7 o'clock every evening.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics":—"Position of Civil Aviation"; and "Performance Calculations of an Aeroplane," by Frederick J. Grose.

"Cabinet Maker":—"The Furnishing of Cottages, Small Houses and Flats"; and "The Cutting of Loose Covers for Cushions."

"Chemical Age":—"Pneumatic Handling Installation for Calcium Sulphide," by G. F. Zimmer; correspondence on the new Benzol problem and the Organisation of Chemists; and "Constitution of Inorganic Compounds," by Prof. G. T. Morgan.

"Fruit Grower":—"A Day's Work"; "Soil Aldehydes: A Problem in Plant Behaviour"; and "Fruit Growing in the West Country."

"Gas World": "The Gas Industry in Scotland"; Analyses of accounts of Scottish gas undertakings; and "The Correct Use of Gas."

"Hardware Trade Journal":—Illustrated articles on Tool Steel Economics and Welding for Repair Work; "How to start a Retail Business" (continued); Metal prices at home and abroad, and special metal charts.

"Ways and Means":—"The Fun of the Fair," by C. E. Hughes; "Housing in the Midlands," by Joseph B. Hobman; and "The Minimum Wage Legislation of the World," by Victor Gollancz.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,187. [Vol. LXXXIV. No. 16.] FRIDAY, APRIL 16, 1920. PRICE ONE SHILLING. *By Post, 1s. 1d. Abroad, 1s. 2d.*

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Notes.

The New Electricity Bill.

IN accordance with the legislative programme foreshadowed in the King's Speech Sir ERIC GEDDES introduced into the House of Commons, on Tuesday, a Bill to amend the Electricity (Supply) Act passed last session. This Bill will not be printed for a few days, and it is therefore impossible at the moment to discuss it in detail, but it is evident that it seeks to enact the compulsory clauses which were dropped like hot cakes last December when the parent measure was before the House of Lords. At that time, the need for the appointment of Electricity Commissioners to deal with the problems of post-war electricity supply in this country was urgent—how urgent the general public and Parliament certainly did not realise—and it was, therefore, wise to lighten the ship of the heavy cargo of the controversial clauses, relating to the appointment of District Boards and of finance, in order that the really valuable freight might be brought safely to harbour. The new Bill, which consists of the dropped clauses, is not likely to have an easy passage, and we hold ourselves in readiness to criticise its provisions. Nevertheless we think its principles are right. The Commissioners certainly require some powers for compelling the recalcitrant, if only for the good of the more progressively minded. The fact that they have such powers does not mean that they will use them—or even need to use them. The awful penalty attending the commission of murder does not make the average citizen lose one second's sleep, nor need the fact, that all or parts of his undertaking may be commandeered, worry the station engineer who is not wedded to reaction. Finance is the rock on which we fear the Bill may split. It contains a clause enabling financial assistance to be given to the extent of £25,000,000 by means of electricity bonds. This procedure is very objectionable to a number of strongly vested interests, and the Government will need all their force to press it through. To those whose interests are not vested it is obvious that some financial powers must be given to the Commissioners if a "cheap and abundant" supply is to be an accomplished fact within the near future.

Defects in Gas Works Electrical Plant.

To be able to see ourselves as others see us is often equally salutary whether we be Scotch men or electrical engineers. And as we cannot be numbered among those who think that perfection has been reached in electrical design and manufacture, but rather consider there is still a great deal to be learnt in the two fields, both from our own mistakes and from the criticism of the outsider, we have read with interest an article by Mr. E. DAVIES in the current issue of the "Gas World." In this article Mr. DAVIES has done the electrical industry a real service, and our only regret is that his remarks should have been published in the pages of our contemporary rather than in our own columns. The majority of electrical motors, he says, have constructional faults, instances being the use of beechwood blocks in the brushholders, which shrink and cause vibration and insecurity in the fastening of end covers, so that they revolve in case of seizure, and leave the oil chamber upside down. He also speaks of lack of clearance between parts, false economy in the dimensions of commutators and bearings, and insufficient care in the wiring lay-out. This is a formidable indictment, though Mr. DAVIES hardly strengthens his case by showing an evident prejudice against the use of electrical equipment in any shape or form in gas works. Some of his statements, indeed, need hardly be taken seriously, but this does not apply to the outstanding fact that one particular class of users of electrical power is not altogether satisfied with its bargain. That this class is our keen competitor in certain fields is beside the point. Gas engineers recognise the advantages which may be obtained by using electric power for driving the materials handling machinery in gas works, and though they may perhaps be hypercritical about details it will be agreed that their hypercriticism has some basis in fact. In a recent address to the Midland Association of Gas Engineers and Managers, Mr. JAMES R. DUFF takes up the same point of view in discussing the application of electric motors to the driving of coal-crushing plant. He finds them unsuitable for conditions where dust and damp prevail, so much so that at Banbury they have been replaced by a steam engine and the chain drive. As regards freedom from troubles a steam or gas engine is, he thinks, to be preferred, not withstanding the undoubted convenience of electricity. Such defects as these two gas engineers point out are worth the attention and remedy of those concerned. We have sufficient faith in the future of the electric drive to think that these criticisms will do good, and that the real quality of the service provided will, in spite of these minor faults, lead to its increasing employment even in gas works.

The Electrical Equipment of Artisans' Dwellings.

The near future will, we hope, see the addition of a large number of small consumers to the mains of every electricity supply undertaking in this country. This additional load will, however, increase the responsibilities of the already harassed station engineer, and under certain conditions may prove the reverse of a paying source of revenue. First and foremost there is the copper question. The network of a number of undertakings is at present strained to the utmost at times of peak load, and additional consumers will, therefore, mean expenditure on cables when prices of both material and labour are ruling high. Secondly, there is the small consumer himself. It is evident that he can only be a paying proposition to the supply undertaking if the necessary costs of installation are reduced to a minimum, and if he pays his fair share of the expenses. These are most important questions which require discussion and re-discussion; and most of all require a speedy solution. In an article which we publish in this issue, Mr. James Cleary, Consumers' Engineer, Brighton Corporation Electricity Works, puts forward his views on the question so far as tariffs and outside work are concerned. These views are doubtless open to criticism, but at the present time this does not make them less valuable. He quite rightly inveighs against what he calls "the minus profit" consumer, a class conveniently represented by such places as garages and lock-up shops where current is only taken for lighting, and points out that the cost of collection, interest and other charges connected with the meter installation and the frequent failure of the latter to register on small loads, are all points which make this type of consumer quite undesirable in these economical days. His remedy is automatically to limit the consumer's demand to, say, 500 watts or even less, and to charge him on that demand a fixed sum depending on the local conditions. The idea is not new. Some such system on lighting circuits at any rate has been in use at Southend-on-Sea and doubtless at other places for some time. It has, however, the advantage of simplicity, for the consumer knows exactly what he is paying, and the supply engineer what he is getting. But the obstacles to its adoption seem to have been the design of an efficient limiter, and the determination of a suitable fixed charge. Mr. Cleary also advocates the use of what may be called the "ring-main" system of service, an arrangement which seems to have distinct benefits when the extended lay-out of the houses in the new Government Schemes is considered, not only as regards continuity of supply, but as regards economy of conductors. The same arguments, Mr. Cleary considers, also mitigate against the use of overhead conductors. This is not a view which will be generally held, but the regulations, and to some extent conservatism, will, we expect, prevent any general employment of the overhead system. A second article by Mr. Alan Kirk deals concisely with the various possible systems of internal wiring. By the use of present day figures (a welcome feature!) he shows that though the cleated system is the lowest in cost, this advantage is largely counteracted by its high "installation time," and taking it all in all the screwed conduit system offers the greatest advantages. This is a conclusion which we do not expect to see generally accepted, though discussion may lead us to alter our opinion. These questions of cost and system, however, are not so important as actually seeing that all new houses are electrically equipped, and we should be less anxious of the future if we thought that everything possible was being done in this respect.

Definite Conditions of Contract.

In the current issue of "Ways and Means" there is an instructive article on "The Disappearance of the Contract." Probably there is no section of the community so interested in the subject of contracts as engineers who have to enter into this form of undertaking for work which may take a year or two to complete. Before tendering for a modern generating set, or for the equipment of an electric railway, an engineering firm must make elaborate calculations and inquiries as to the probable course of the market in the raw materials required, the state of the labour market, and the probability and even the possibility of demands for increased wages, &c. However prudent and careful the firm may be, the estimates thus made may turn out to be erroneous, and we are not surprised that contractors try to safeguard themselves by reservations exonerating them from delays caused by strikes and lock-outs, and from loss due to increases in the price of coal and raw materials. As our contemporary rightly points out, English commerce has been built upon a system of which the contract is the foundation. During the war many unusual restrictions and reservations upon the usual practice were necessary. We agree that "the revolution in our habits in connection with contracts is not due to the Government; the labour situation has a very definite bearing on the matter. So long as the trade union movement was actuated only by economic considerations, those who were in the habit of making contracts could estimate the possibilities of the labour market just as they gauged the possibilities of every other market. But the mixing up of trade unionism and politics has introduced a new uncertainty which reacts on this matter of contracts. Many of our trade unionists are not now so much concerned with mere wage advances as with their desire to unsettle public confidence for the simple purpose of weakening the system upon which trade and industry is now carried on. Those, therefore, who in former days arranged by contract for the steady activity of our industrial forces are faced with the prospect of constantly recurring political strikes, and another difficulty is thus placed in their way. It seems to us that we must get back to the contract system, and to that end we must continually strive to remove from the industrial sphere all these outside influences which are doing such havoc to the commerce and industry upon which we all depend." This is very excellent and sound advice, and we hope that every effort will be made to educate the workers so that they may have a proper appreciation of the evil results of unstable market conditions. In contracts, and expecially those relating to export orders, price and time of delivery are the two most important elements. Great Britain has recently lost several orders through high prices, and through inability to guarantee delivery as quickly as our foreign rivals. If we are to recover our commercial supremacy, we must quickly get back to the condition of the stable, definite contract, and propaganda to show all classes how necessary this is, is urgently required.

Industrial Troubles.

The strike of tramwaymen against the terms arranged for them by their leaders was only sectional in character from the very beginning, and work has now been resumed even at Manchester and Salford. On the other hand, there is a good deal of unrest at Birmingham and other places, and a feeling, which it is to be hoped is not held by more than the hot heads who are so vocal at strike meetings, that unless the full demands are granted, a national strike should be declared. In the mining industry the outlook seems at the moment rather brighter, if the unofficial figures of the result of the ballot are to be believed. That seething cauldron of discontent, South Wales, has, of course, voted for a strike, and its example has been followed in Lancashire. But the majority of the districts have voted for the acceptance of the Government's terms, and it would therefore appear probable that the strike is postponed for a season, though as is not unusual on these occasions there is local trouble in Staffordshire and South Wales, which may spread and form a further excuse for trouble. On the other hand there has been a sudden strike at the Southampton Electricity Works over a disagreement between members of the Electrical Power Engineers' Association and the Electrical Trades' Union, which has resulted in the stoppage of the power and traction supply, and the reduction of the lighting to what can be given by the personal efforts of Mr. Harry Ellis, and a small voluntary staff. The whole of Ireland, except the North-East, is petrified by a general strike. The railwaymen are also restive, though the statement that they were claiming an all-round advance of £1 a week is denied by Mr. Bromley. The Transport Workers are anxious for more wages, and the Dockers are also disposed to enforce their claims, especially in view of the favourable report of Lord Shaw's Court of Inquiry. Agricultural labourers are also making further demands, and the Postal Workers are not behindhand on the same road. It is not a cheerful prospect. and the increased cost of the necessaries of life which must follow these increases in wages is, though more noticeable, less important in its effects than the turmoil and irritation caused by the constant strife which seems almost to have become a permanent feature of our industrial operations. Care killed the cat, and strikes and the irritation caused by them will kill British Trade. And that will do no one in this country any good. Both employers and employees must suffer under present conditions. The irritable state of mind to which they give rise reduce both personal and corporate efficiency, and the time which might be more usefully employed in productive work is now taken up in negotiations which lead nowhere, and are constantly being resumed with like results.

Motor Car Headlights.

In the days preceding the war the question of regulations for motor-car headlights had already begun to attract attention, on account of the very varied treatment the problem received by local authorities throughout the country. During the war, when public lighting was generally reduced almost to extinction, the regulations introduced were more stringent, but for a time the position was very confused, a motorist in one area being penalised for complying with requirements demanded in an adjacent district. The D.O.R.A. regulations brought about better uniformity, but even to these there were exceptions. Meantime, in the United States, matters had run a more normal course, and there seems to be now at least some degree of uniformity of principle in the regulations of the various States. although the actual details vary. The whole question was discussed in an introductory Paper by Mr. J. W. T. Walsh at a recent meeting of the Illuminating Engineering Society—a discussion that was the more timely on account of the recent interim report of the Committee on Lights and Vehicles sitting under the Ministry of Transport. While agreeing that unduly powerful headlights are in general use, and emphasising the need of avoiding dazzle, this report did not attempt any definite prescriptions for its avoidance. On the other hand, the laws of various American States, and the recommendations made by the Illuminating Engineering Society in that country, as summarised in Mr. Walsh's Paper, do contain fairly definite stipulations. A feature of these is: (*a*) A limitation of candle-power for the main driving beam; (*b*) a limitation of the beam below a certain horizontal plane, *e.g.*, 42 in. above the road surface, and (*c*) requirements as regards the illumination available a certain distance ahead of the car. Mr. Walsh concluded his Paper by a series of questions, which furnished an excellent basis for discussion. One can appreciate the difficulty of framing suitable regulations to be enforced by the police. The requirements of the driver on the one hand and the pedestrian on the other are, in many respects, conflicting. Some of the devices described by Capt. Stroude and others in the course of the discussion seem to represent scientific efforts towards the solution of the problem, but, as Mr. Newton remarked, what is really needed is a device which can be readily applied to existing headlights, of which many thousands are in use. Mr. Gaster insisted on the close relation between the problem of headlights and the provision of street lighting, and there is much to be said for the view that both should be considered conjointly by a central authority. It is evident that a good deal of further spade work in the form of experimental tests under the varied weather conditions prevailing in this country is needed. As in their recent discussion on the lighting of mines, the Illuminating Engineering Society has outlined the road investigation should follow, and paved the way for scientific treatment of an admittedly complex problem.

Some Light on Railway Policy.

A White Paper, somewhat curiously entitled "Ministry of Transport Estimates, 1920-21, Statement as to Railways," throws a faint light upon the policy which the Ministry of Transport proposes to follow in carrying out the electrification of the railways of this country. The companies are to be encouraged to spend their own capital on electrification schemes, particularly on suburban electrification schemes, whenever a well-considered scheme can be produced. This sounds rather a cat and mouse policy. When capital has been raised, which is in itself a matter of some difficulty at present, especially for railway companies, and the scheme has been thought out by those who know the operating conditions on the particular railway, the Ministry will then, we suppose, step in and make suggestions which will have the compelling power of a Royal invitation. It is perhaps not a policy which will give the best results, but like all policies its success will largely depend on how it is carried out. The tendency of the Government official is to assume universal knowledge on every subject, and to neglect the advice of the expert when that runs counter to his own ideas. We hope that the Ministry of Transport will be exceptional in this respect. A good first step has been taken in the appointment of a Committee to consider the technical side of the electrification question, and the appointment of a similar body to deal with the traffic side would be welcome. For the efficient carrying of "electrified" suburban traffic is a problem by itself. Electrification means that not only can a larger traffic be dealt with, but that a larger traffic is produced, and this trait, which may almost be called a disadvantage, wants careful consideration, as it must be dealt with somehow, and it must be dealt with speedily. In other words, the Ministry of Transport or its committee of traffic experts must plan ahead, otherwise they will never even relieve the present situation by electrification, and may conceivably make matters worse. When we write about traffic problems we instinctively think about London, but the same conditions apply in any industrial districts, and a consideration of the two problems of engineering and traffic must be made together for all such districts throughout the country.

Trade and the Excess Profits Tax.

The effect of post-war conditions on the manufacturing side of the electrical industry was well illustrated in Mr. George Sutton's remarks at the annual general meeting of Messrs. W. T. Henley's Telegraph Works, Ltd. As regards trading, the year has been a successful one, the company is in a sound financial position, and Mr. Sutton was quite rightly optimistic about both the past and the future. But the Government have not yet got away from the war time idea that trading concerns can be controlled, have their profits limited, and be heavily taxed on what profits remain, without a weakening of their stability. Bleeding is good for the plethoric in moderation, but in excess it is unwise, and for the anæmic it is dangerous. The effects of the present commercial and financial limitations are not unlike those that follow the surgical operation we have just mentioned. In the past year there has been an abundance of work, but contracts can only be obtained overseas if the burden of taxation is reduced. Home trade may be important, but overseas trade is much more so. How heavy this burden of taxation is, may be gathered from Mr. Sutton's statement that while in 1911 Henleys were taxed about £12,000, in 1919 this had risen to £100,000, which, large as it is, is a sum below the average of the war years, while a total of £400,000 had been paid in excess profits duty. The company's policy in the past, like that of many other similar undertakings, has been to pay for its extensions from its undivided profits. This is a course not only advantageous to the shareholders, but to capital and labour alike, and such a severe limitation of profits as we have indicated will leave both poorer. We are glad, therefore, to see that there is some chance of the excess profits tax being dropped in the forthcoming Budget. It is a tax which has brought in large sums to the Exchequer, but nevertheless it has almost certainly done more harm than good.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

Mr. Alan Kirk contributes an article on "Wiring for Electric Light in Small Houses" on p. 417, in which he discusses the different possible systems from the point of view of safety, cost and life. He concludes that, taking everything into consideration, the screwed conduit system is the best for this class of work.

On p. 418, in an article on the "Electrical Equipment of Artisans' Dwellings," Mr. James Cleary deals with the importance of establishing a simple tariff which shall make all kinds of consumers contribute their share to the revenue of the undertaking. He shows how this can be done by means of a current limiter, and also deals with certain features which will have to be introduced into the network system for the new houses which are now being erected.

We give an abstract on p. 420 of a Paper read by Mr. L. J. Hunt on "The Single Field Cascade Machine" before the South Wales Institute of Engineers.

On p. 422 we give a description of some modern electrically-driven conveying machinery which has been designed and erected by Messrs. Fraser & Chalmers for purposes such as handling of coal, gold waste and other similar material.

We reproduce, by permission of the "Gas World," a short article by Mr. Davies on "Defects in Gas Works Electrical Plant" on p. 424.

We also give on p. 424 an account of the discussion at a recent meeting of the Institution of Electrical Engineers, at Birmingham, on Major K. Edgcumbe's Paper on "The Protection of Alternating-current Systems without the Use of Special Conductors."

Our Leading Article deals with the report of Major-General G. O. Squier to the Secretary of State on the work done by the Signal Service of the United States Army during the war (p. 427).

Arrangements for the Week.

FRIDAY, April 16th (to-day).

N.-East Coast Institution of Engineers and Shipbuilders.

6.15 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "The Casting and Treatment of Steel," by Dr. J. H. Andrew.

Institution of Electrical Engineers.—Students' Section.

7 p.m. At Faraday House, Southampton-row, London, W.C. Paper on "The Vacuum Tube as a Transmitter and Receiver of Continuous Waves," by Mr. J. Scott-Taggart, M.C.

Technical Inspection Association.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper on "Labour Unrest—Its Causes and Its Cure," by Mr F. R. Wade, M.B.E.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Aeroplanes: Historical Survey and Progress," by Mr. A. Knight Croad.

SATURDAY, April 17th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "The Thermionic Vacuum Tube," by Prof. W. H. Eccles, D.Sc.

Birmingham and District Electric Club.

7 p.m. At the Grand Hotel, Colmore-row, Birmingham. Paper on "Electric Heating and Cooking," by Mr. F. F. D. Davidson.

MONDAY, April 19th.

Institution of Electrical Engineers.—Informal Meeting.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn-buildings, High Holborn, London, W.C. Discussion on "Group *versus* Individual Driving," to be opened by Mr. G. H. Ayres.

North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle-on-Tyne. Annual General Meeting. Lecture on "Electricity in the Western War Zone," by Major T. Rich, O.B.E.

Institution of Automobile Engineers.—Scottish Centre.

7.30 p.m. At the Royal Technical College, Glasgow. Paper on "The Most Suitable Steels for Automobile Parts," by Dr. W. H. Hatfield.

Institution of Electrical Engineers.—Liverpool Sub-Centre of the N.-Western Centre.

7.30 p.m. At the University, Brownlow-street, Liverpool. Eleventh Kelvin Lecture on "Modern Marine Problems in War and Peace," by Dr. C. V. Drysdale.

TUESDAY, April 20th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "Recent Advances in X-Ray Work," by Major G. W. C. Kaye, O.B.E. (Lecture II.)

Institution of Civil Engineers.

5.30 p.m. At Great George-street, London, S.W. James Forrest Lecture on "Coal Conservation in the United Kingdom," by Sir Dugald Clerk, K.B.E., F.R.S.

Institution of Electrical Engineers.—N.-Midland Centre.

7 p.m. At the Hotel Metropole, Leeds. Paper on "The Protection of Alternating Current Distribution Systems without the Use of Special Conductors," by Major K. Edgcumbe.

North-Western Centre.

7.30 p.m. At the Municipal College of Technology, Sackville-street, Manchester. Kelvin Lecture on "Modern Marine Problems in War and Peace," by Dr. C. V. Drysdale.

Illuminating Engineering Society.

8 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Discussion on "The Lighting of Churches" to be opened by Mr. J. Darch.

WEDNESDAY, April 21st.

Institution of Electrical Engineers.—South-Midland Centre.

7 p.m. At the University, Edmund-street, Birmingham. Kelvin Lecture on "Modern Marine Problems in War and Peace," will be delivered by Dr. C. V. Drysdale.

THURSDAY, April 22nd.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "The Tensile Strength of Liquids," by Mr. S. Skinner, M.A.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. At the University, Liverpool. Lecture on "The Sea Shore," by Mr. W. Rimmer Teare.

FRIDAY, April 23rd.

Physical Society.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Fourth Guthrie Lecture on "The Anomaly of the Nickel-Iron Alloys; its Causes, and its Applications," by Monsieur C. E. Guillaume.

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, London, S.W. Papers to be read: "On the Hardening of Screw Gauges with the Least Distortion in Pitch" (referring to Water Hardening) and "On the Hardening of Screw Gauges with the Least Distortion in Pitch" (referring to Oil Hardening), by the late Mr. W. J. Lineham, revised by Mr. G. T. White.

Institution of Electrical Engineers, North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle-on-Tyne. Kelvin Lecture on "Modern Marine Practice," by Dr. C. V. Drysdale.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Modern Developments in Motor Car Design," by Mr. R. S. Fox, M.A.

Wiring for Electric Light in Small Houses.

By ALAN KIRK, A.M.I.E.E.

The present time, when the housing problem is so much to the fore, appears to be a favourable moment to make a general survey of the systems and methods that can most advantageously be adopted in wiring small class property for electric lighting. As it is necessary to limit the scope of such survey in this article we shall confine out attention to the class of building that comes under the head of Workmen's Houses or Dwellings. The necessary data to be considered for the wiring of a workman's house or cottage would probably be quite useless if applied to the wiring for a more pretentious residential property.

In considering the wiring for the type of dwelling under review we must bear in mind that the standard of living of the working classes has reached a high and somewhat luxurious level. We must also accept as a governing factor the reality of children and children's ways in adopting any scheme of wiring.

The Essentials of an Ideal System.

Let us first consider what are the essentials for an ideal system—

1. Safety from shock and fire.
2. Low initial cost of materials and labour.
3. Long life with low maintenance.

To eliminate all possibility of danger to life by means of electric shock or fire it is necessary that (*a*) all current carrying parts must be covered or insulated with materials having a high insulation resistance, which in turn must be protected with a strong mechanical covering or (*b*) all current carrying parts must be placed in such a position that they can neither be disturbed nor touched. To lessen the initial cost it appears to be necessary to reduce, as far as possible, the use of all highly manufactured and proprietary articles, decrease the amount of highly paid skilled labour, and, by careful planning, restrict the quantity of materials required. To obtain long life for the installation it is necessary to select, carefully, materials that do not quickly deteriorate, place them in positions where they are least likely to suffer from outside influences and carefully supervise the work whilst in course of erection.

Before proceeding further, we will examine the present day methods and materials commonly in use to see how far they meet the foregoing requirements.

Cleated Wiring.

This system of wiring, insulated wires carried on porcelain cleats, was largely used during the period of war for the wiring of army hutments, &c., and was eminently suitable for that class of temporary work. To apply cleated wiring to workmen's houses, and bearing in mind our previous considerations, it is obvious that if used it must be an "out of sight" system, that is run in the roof and under the flooring. How near do we come to our essential points—

1. *Safety.*—Although the wiring under floors is where it cannot be touched, it can still be disturbed by nails or screws driven into the floor boards, and is at all times liable to be both touched and disturbed when work of other trades is being attended to. It has no auxiliary mechanical protection.

2. *Initial Cost.*—The initial cost of materials is comparatively low. At first glance labour would also appear to be low, but this is eroneous, in reality labour in comparison with materials is high on the total cost.

There are several reasons accounting for this the "installation time" is extremely restricted, *i.e.*, the wiring cannot be put in until the floor joists are in position and the flooring ready for laying, owing to the extreme risk of damage being done to the wires and cleats by other trades working, incidentally this restricted time is liable to cause delay to the work of other trades.

One item of labour often lost sight of is the boring of holes through joists for the wires to pass through. We are assuming that good work is contemplated, and that a separate hole will be allowed for each wire, and that the joist will only be bored through its neutral axis. A further item which, although not properly coming under the classification of "cleated wiring," must be taken into account, is the provision of protection for the vertical drops of wiring to the switches. The wires cannot be taken down the surface of the walls on cleats, therefore some means of mechanical protection must be provided which at once introduces a part of another system with its concurrent expense and faults, if run on the surface this would probably be wood casing and capping, if buried behind the plaster it must be steel conduit.

3. *Life.*—The life of cleated work is long and maintenance low, but only for so long as it is undisturbed. There is also the life of the other system introduced for down drops upon which it is dependent for its life and maintenance, inasmuch as "the strength of a chain lies in its weakest link."

Wood Casing and Capping.

This system of carrying insulated wires in grooved wood casing with screwed on capping can only be used on the surface with safety, and has little to recommend it at the present time as—

1. *Safety.*—The risks from shock are small, but the risks of fire are high.

2. *Initial Cost.*—The cost of materials and labour are both comparatively high, and the "installation time" is very restricted.

3. *Life.*—The life compared with cleated work is short and maintenance high.

Lead Covered Systems.

These systems (and we include generally the many systems that depend upon a thin envelope of metal for their mechanical protection) are only suitable for surface work, and may be useful in certain cases, but for the class of dwelling under discussion they are very unsuitable, and may safely be relegated to a more useful sphere as their cost is comparatively high in both material and labour, safety is low and life is liable to be short.

Conduit System.

There are only two systems of conduit that can be admitted, "screwed" and "grip joint."

The plain slip joint system of conduit is prohibited by the Rules of the I.E.E. Unfortunately, it is still indulged in by a certain class of contractor, who place their pockets before their honour. It is not proposed to go farther into the "grip" system of conduit than to remark that practical experience has demonstrated that this system, if conscientiously installed, has no advantage over the screwed system from the point of safety, cost or life.

The "screwed conduit system" consists of insulated wires drawn into steel conduits which have previously been erected, where one conduit has to connect with another the two ends are screwed into a socket, box or other suitable accessory. It is essential that all conduit systems, and any system having a metallic outside protection, shall have such outside covering efficiently connected to earth. To meet the requirements of an ideal system it should be made compulsory that *all* metal that is not carrying current must be earthed, this would at once fill our essential as regards safety to life, and would wipe out the present monstrosities that have been called into existence to cover up faults without remedying them, but are in accordance with Board of Trade Regulations.

Assuming that we have a properly planned and carefully executed conduit system—

1. *Safety.*—This system meets our requirement (*a*) all current carrying parts must be covered or insulated with materials having a high insulation resistance, which in turn must be protected with a strong mechanical covering. The risk of danger to life and risk of danger from fire are practically eliminated.

2. *Initial Cost.*—The initial cost is comparatively low for materials, although they consist largely of highly manufactured goods, the cost of labour is comparatively high on the total cost. The labour required is of a more skilled nature than that necessary for cleated work, but this does not adversely affect the cost owing to the antidiluvian system which keeps all wiremen at the same "dead level" price.

The "installation time" is at its maximum with this system.

3. *Life.*—The life is fairly long and maintenance is low.

The Costs of Systems Compared.

To obtain a fair comparison of the actual costs of the systems referred to, it is necessary to decide upon the house we are to wire and then take out our cost for each system, we have therefore selected a seven-roomed house consisting of hall kitchen, scullery, parlour and sitting room on ground floor, and three bedrooms and bath on the first floor. The ground floor rooms are 10 ft. high, and the first floor 9 ft.. The house frontage is 20 ft., and the depth 26 ft. The actual nett cost of wiring for nine pendant points controlled by nine switch points, exclusive of all fittings and accessories is as follows:—

Cleated Wire in roof for first floor points and under first floor flooring for ground floor points: Materials, £2 3s. 8d.; labour, £3 15s. 7d. Total, £5 19s. 2d., or 13s. 3d. per point.

Casing and Capping—on surface: Materials, £2 10s. 10d.; labour, £5 8s. 8d. Total, £7 19s. 6d., or 18s. 9d. per point.

Stannos—on surface: Materials, £2 7s. 11d.; labour, £3 15s. 11d. Total, £6 3s. 10d., or 13s. 9d. per point.

Twin Lead System—on surface Materials, £2 6s. 10d.; labour, £3 13s. 11d. Total, £6 0s. 2d., or 13s. 5d. per point.

Screwed Steel Conduit buried: Materials, £2 10s. 5d.; labour, £1 15s. 10d. Total, £7 6s. 3d., or 16s. 3d. per point.

In all cases switch points have been grouped together on landing for all first floor rooms and in hall for all ground floor rooms.

From the above it will be seen that on actual cost the cleated system is the lowest, but in practice the great restriction of the "installation time" is found to counteract largely the benefit assumed to be gained by low initial cost. Although the actual cost of the screwed conduit system is higher than the cleated, the great additional advantages attained by non-restriction of "installation time" and high safety factor fully compensate for the slight additional first cost, which, if taken as a percentage of the cost of the building and equipping of the whole house, appears only as an infinitesimal amount.

In conclusion, we should like to suggest that if the architect, builder and electrical engineer were to co-operate a means might be arrived at whereby the conducting wires could be placed in such a position that they could neither be disturbed or touched. Assuming that this could be done, then we can at once cut down our costs by using bare copper wires, carried on, say, porcelain cleats, in lieu of the highly manufactured insulated wires, and, at the same time, we could decrease the amount of labour required and increase the length of life of the installation.

Electrical Equipment of Artisans' Dwellings.

By JAMES CLEARY.

The request of the Editor for a further contribution on matters affecting electricity supply is most opportune, as the time has now arrived for deciding upon the method of equipment and connecting up of the many colonies of small residences for which contracts have been placed, and several of which are already well in hand.

The question of network distribution was dealt with in a previous article,* since when there have been opportunities for including the suggestions then made in building schemes in progress with the most satisfactory results. The ducts from house to house having been specified for in the builder's contract, and included in the cost of the house, have been the means of effecting a considerable economy. Instead of house services costing double pre-war prices, they are now reduced to about a third of the old cost. By the old method they would have been increased from £6 to £12, but now are reduced to anything between £2 to £3 for similar services.

The cost of the installation is also included in the builder's tender, such installation being put in during the progress of construction. The many economies outlined having been effected, it is now necessary to consider the question of further economy in affording and maintaining the supply, so that it may not only show profitable results, but be the most profitable work embarked upon in the history of electricity supply. The above economies, considerable as they are, do not go far enough, and greater saving still must be effected to allow for increased costs of fuel, plant, running and establishment charges to make these shoals of little fishes a satisfactory meal.

Tariff for Services Rendered.

For the first time in the history of electricity supply, due to existing conditions, it is possible, if the nettle be grasped, to discriminate in fixing a tariff for small residences which will overcome all anomalies of the past, making this otherwise precarious business a fruitful source of certain profit. Safeguards must, at the outset, be introduced to eliminate the bugbears of the past, the chief of which has been the "minimum charge" consumer, who would have been better named the "minus profit" consumer. Both in the cases where the minimum charge has been enforced, and where the charge has been for current consumed only, in such places as garages, studios, lock-up shops, rack-rented flats and similar places, the cost of collection has often been more than the revenue obtained, to say nothing of the capital locked up in meters, services, fuses, boards, &c., the increased cost of which, with the labour of fixing, must be saved in the future, and form one of the chief economies to be effected. This also applies to the prepayment meter, the cost and maintenance of which makes it prohibitive. Another fault, which is common to both, is the great loss due to unregistered current by the use of small metal filament lamps. As the latter loss is certain to become greater owing to higher efficiency lamps in the near future, it is now time that a tariff were framed which would at least ensure payment for services rendered. Then, again, the introduction of summertime upsets the balance, which must also be adjusted. This change transferred a considerable number of small consumers, who previously were profitable, to the other side of the sheet.

Some Room for Improvement.

Although it may not be possible to recover the losses of the past enumerated above, there is every reason why they should not be allowed to continue, and more especially should not be introduced into the future far-reaching operations. In the past, the advent of a change of tariff has always foreshadowed extra expenditure, mostly for additional meters or other apparatus, and increased work, and even then it has not always had the desired effect. This has been especially so in some cases where "other uses" have been introduced, which necessitated additional meters to register a few units at the lower rate which has often resulted in wasted effort, and in some peculiar cases actual loss of revenue. Any striving for economy must not lead to sacrificing quality, but the highest standard must be maintained, both in workmanship and materials. In respect of cables and wires, this is essential.

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* The Electrician, Vol. LXXXIII., p. 146.

The house installation must cost more than the pre-war prices, but even then it is such a good investment, as it will save its total cost every five years, so that all interested in house construction should specify and pay for the installation of electricity as an illuminant. For electricity not only creates and maintains an atmosphere which is hygienic, but allows of a better finish to the interior decorations, while their longer life justifies its use. It is in the carrying out of the installation work that the contractor makes his contribution to the future all-round success, and every necessary precaution must be taken to ensure this.

The Elimination of Waste.

It now only remains to justify all the foregoing by showing that, by the elimination of waste, both as regards material and labour, and from bad practices in the past, by the application of more efficient methods in the future, how losses may be safeguarded against and profits assured, to the benefit of the supply authority and consumer alike. To effect such a beneficial change, objection must not be made to the rate or altitude of the flying, so long as the stability and the handling of the machine is satisfactory.

The first thing necessary is to remove all restrictions against the free use of small current-consuming devices that should beneficially find a place in every home, according to requirements. This must be made possible without additional expense to the consumer for installing, unless it is an occasional request for apparatus above the capacity of the wiring. Without extra wiring a wide range of apparatus not exceeding 500 watts might be introduced into every house in the schemes now under consideration. The service should be available for the early morning cup of tea, shaving water, making toast, heating milk, making coffee and later working a sewing machine or ironing, and the occasional use of vacuum cleaner, a small grill or egg boiler, and many other labour-saving devices which would be a great boon in every house, and whose use could be so arranged that, if desired, the maximum of 500 watts was never exceeded. If the consumer for any reason does not require so high a maximum, he should have facilities for the free use of any lesser amount, say down to 100 watts, that he is prepared to pay for.

The Adoption of a Kilowatt Demand Tariff.

The difficulty of obtaining meters, the cost of purchasing, the cost of labour for fixing, reading, recording and maintaining of same, due to the all-round increases, now necessitates an alternative method of charging, and one which will overcome all existing trouble will be welcome. The magnitude of the prospective building schemes justify the adoption of a kilowatt demand tariff for this work. This can now be applied by a simple piece of apparatus which is foolproof, robust and reliable, not affected by short-circuit and automatic in action, while the cost of maintenance is quite negligible.

There may be much concern about the price per kilowatt to be charged. Obviously this must be settled on a profitable basis for each district, and it must not be supposed that it will be possible in the residential areas of the south to fix the same price as that obtaining in the industrial towns of the north, where the close proximity to the coalfields must always be an advantage. But where £8 to £10 per kilowatt cannot be offered it should be possible to fix a price within double that range in most districts. But, even if £26 per kilowatt were charged, a lighting supply not exceeding 100 watts demand would cost the consumer rather less than the minimum charge obtaining to-day. The need for deposits to safeguard the account would be avoided and the risk of bad debts overcome by instituting a system of payment in advance monthly, or by including amount due in the rent and collecting it weekly. For users above 500 watts, which in this class of property would be the exception, it might be necessary to vary the charge. This could be arranged with the same controlling apparatus.

On the grounds of simplicity alone the above scheme will become popular, as it contains no grounds for objection from any quarter. Even those in the gas interests cannot now object, as there will be no difference between the price for power and lighting. This may easily lead up to a further economy still by saving the rental of gas meters where they are no longer necessary.

The Scheme Explained.

The device referred to above is suitable for operation both on direct and alternating current. It not only controls the current, but, if the amount contracted for is exceeded, it operates by reducing current consumption and illumination by half, and directly the excess current is switched off the full voltage is automatically and instantly restored.

Taking the pre-war cost of service lines, meter, fuses, board, reinstatement, and fixing at an average of £12, instead of this being inflated by the ever-increasing costs, it will, under the scheme now suggested, cost not more than half. By the linking up of groups of adjacent houses on a ring system fed from both extremes, although as many as 50 cottages may be supplied through two services only, the chance of interruption of supply is reduced to a minimum, as an alternative feed is provided to each cottage, an advantage not enjoyed by consumers supplied through a separate and costly service. Another advantage is that the full capacity of the ring main is always available for efficient use, whereas with the separate service system the reserve of conductor in the case of the small user, who is in by far the greater proportion, is wasted.

In the general lay-out of the new building schemes the requirements of the Ministry of Health necessitates the houses being built in pairs or in very small blocks, in positions too far back, as a rule, for separate treatment, even though the revenue were sufficient to support such an arrangement. Then, again, the mains network would, in most cases, have to be duplicated owing to the wider space, being occupied by gardens and grass plots, in addition to the roads, separating the cottages on opposite sides. The same conditions militate against overhead construction, which, with all its drawbacks as a permanent scheme, could not even compete as regards cost if the work is to be done in a satisfactory manner. The present price of poles, brackets, insulators and cables makes this work prohibitive, apart from the labour for erection, the cost of which is certainly worth avoiding, especially as a solid lead-covered twin cable of ample capacity can be provided at an over-all average charge of £2 per cottage after the ducts have been provided as a part of the building.

The sparsity of network boxes, the almost total absence of joints underground, and the complete immunity of the many risks common to electricity supply cables, are also invaluable features in the system of interior linking up here advocated, and wherever it is applied, the mains man of the future will have a soft job compared with that of his predecessors, and must benefit accordingly. It is hoped that the many advantages of the linking-up system here advocated will be appreciated to the full, and wherever possible acted upon, as it not only scores on the grounds of economy, but, which is more important, on those of efficiency also, the immunity from future trouble alone justifying the change. The old axiom that "prevention is better than cure" applies in a very special sense to the distribution of electricity, and the opportunity now available of removing the distributing cables from the province of the road excavator is one that should be embraced in the lay-out of all the housing schemes now in course of construction.

The foregoing is not intended as a specific for application in all phases of existing trouble, but just as a few suggestions to overcome the ill effects of high cost of materials and labour obtaining to-day, and by so doing make what would otherwise have been a profitless venture or a rejected opportunity a successful advance in this particular field, the experience in which will eventually be reflected in other directions, to the benefit of the electrical industry and the nation as a whole.

The Single-Field Cascade Machine.*

By L. J. HUNT.

In the old scheme of cascade working two separate machines were used; the stator of the first was connected to the mains and its rotor to the stator of the second machine. When running at cascade speed the second rotor was short-circuited. An alternative method was to connect the rotor of machine "A" with the rotor of machine "B," the stator of which was then short-circuited. The rotor windings had to be so connected that the currents circulating in them produced fields in the two rotors rotating in opposite directions, otherwise the torque developed by motor "B" would be opposed to that developed by motor "A."

Where two separate motors are used, there will be two entirely separate magnetic fields and windings, whereas in the "single-field" type of machine only one core is used, and the two component fields merge into a single resultant. Similarly, the two individual stator and rotor windings are replaced by single windings. The stator winding is so arranged that both the "main" and "slip frequency" currents can circulate in it independently. In the rotor a single winding is so connected that the currents induced in it produce two magnetic fields. Fig. 1 shows a field system having four salient poles excited by currents fed in at the diametrically opposite terminals marked "line." At similarly situated points at right angles to the "line" terminals are two terminals marked "tappings," and the currents flowing between these points produce a magnetic field of two poles, N.N., S.S. In the stator winding of a cascade induction motor the same idea is used; the alternating-current circuit is connected to the "star" terminals, and, by short-circuiting the "tapping" points, circuits are provided for the currents induced by the auxiliary magnetic field which originates in the rotor. In the synchronous motor and self-paralleling generator we have the same idea, but, as the tapping frequency is zero, direct current is supplied to the stator.

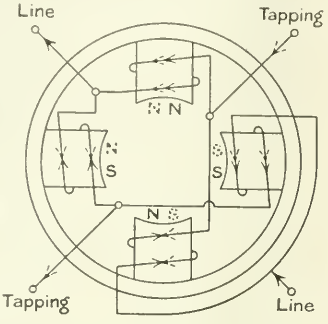
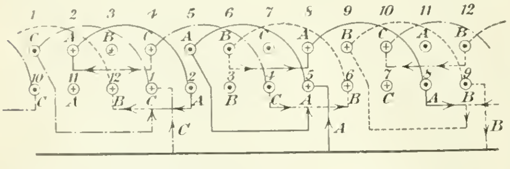


Fig. 1.

Electrically and magnetically, the "single-field" motor is identical in its action with the cascade combination of two separate machines; the combination of windings and fields only affects the cost efficiency and power factor. If one thinks of the single machine as if it consisted of two separate elements, the theory becomes quite simple. A stator winding connected to the supply produces, say, eight poles. This field induces currents in the rotor windings which produce both an eight-pole and four-pole effect. The rotor winding produces these two distinct fields owing to the manner in which the coils are arranged. The eight-pole element corresponds to the main stator field, and the four-pole field, which rotates in the opposite direction, induces voltages in the stator winding, which is so connected that induced currents can flow independently of the currents supplied by the mains, and these currents produce a field which corresponds to the pole rotor field. The winding and the main and induced currents flowing in it are shown in Fig. 2, the conductors being numbered from 1 to 12, and connected to form an interconnected star and mesh winding. Assuming that the main field induces instantaneous voltages, A, B, C, in the rotor winding, as in Fig. 3, the corresponding currents are shown in key diagram, Fig. 4. The currents are unevenly distributed, because they are producing two magnetic fields, one of which corresponds to the main field of four poles (which induces the rotor currents). The individual bars of the four-pole stator winding carry currents which cancel the four-pole effect of the rotor winding. At the instant considered, $B = 1$, $A = 0{\cdot}5$ and $C = 0{\cdot}5$ amperes. In any pair of slots currents $A + C = B$; $B - C = A$; $B - A = C$.



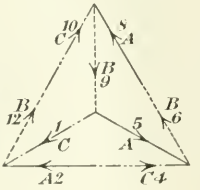


Fig. 2.

In two-speed motors with the slip-rings short-circuited the currents in each section of the winding are in phase with the corresponding voltages, and they do not produce any second field. The motors so connected run as normal motors at speeds corresponding to the number of poles in the main winding. Two-speed motors are wound for speeds corresponding to 8 poles and 12 poles, 12 and 18 poles, 16 and 24 poles, 20 and 30 poles, &c., the second speed being usually two-thirds of the full speed; but a further type has been developed, in which the number of main poles is double that of the auxiliary number, and speeds are obtained in the ratio 3 : 1. The full speeds of these motors may be made to correspond to any number of poles greater than two. The rotor windings are the same as used for two-speed motors and have three slip-rings.

Additional speeds can be obtained in a single motor by using a second winding in the stator and by subdividing the rotor windings and replacing each of the single groups of windings by two or more sets of coils connected in parallel. With this rotor winding, each pair of parallel connected windings acts as a short-circuited path when acted upon by the second stator winding. Speeds corresponding to 4, 6, 8 and 12 poles, 6, 8, 12 and 18 poles, &c., can be obtained. Three slip-rings are used.

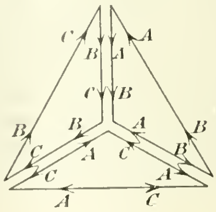


Fig. 3.

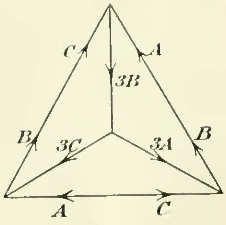


Fig. 4.

Another method of increasing the number of speeds, applicable to large motors for driving rolling-mills, colliery fans, compressors, &c., is by the use of a second motor connected in cascade with the main cascade machine. If this auxiliary machine is provided with a change pole stator winding and a squirrel-cage rotor, the whole control can be effected by means of a single controller.

Synchronous Motors.

When a cascade induction motor is running on load, the auxiliary field is rotating backwards round the rotor at a greater speed than it is being carried forwards by the mechanical rotation of the rotor. It therefore rotates slowly backwards in space, but at synchronism it would be stationary. If, then, direct current is fed into the stator windings in such a manner that it will produce a stationary field having the same number of poles as the auxiliary rotor field, the two will lock, and the machine becomes a synchronous motor. To make the stator winding suitable for direct-current excitation, it is divided into two star windings put in parallel by connecting together the corresponding terminal points.

The 12 pole machine is started as an eight-pole motor by resistances connected to the slip-rings, and is brought up to a speed above synchronism (500 revs. per min.). Three slip-rings are then short-circuited by a switch, which also connects the exciter to the stator. Short-circuiting the rings changes the distribution of the rotor currents and develops the auxiliary field, which, by locking with the stationary field in the stator, brings the motor into synchronism without any rush of current. The starting and synchronising resembles the starting of a two-speed cascade machine, the only difference being the substitution of synchronising switch for the tapping short-circuiting switch of the induction machine. As the motor starts up with only two-thirds of its poles, the magneting current taken from the line is small, and the starting torque on full load takes only 12½ per cent. more current than when running in synchronism at full load. The starting power factor for this load is over 93 per cent. Fig. 5 illustrates the starting characteristics of this machine. When driving the fan, the machine works with a leading power factor of 70 per cent., and raises the power factor of the whole colliery plant approximately to unity. This motor runs under peculiarly difficult conditions for a synchronous machine, as the total capacity of the power plant is only 750 kw., and therefore this motor absorbs a large proportion of the output of the station. It was essential that the design of the motor should allow of synchronising without any violent disturbance of the line, in order that the numerous haulage and other motors should not be affected.

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* Abstract of a Paper read before the South Wales Institute of Engineers.

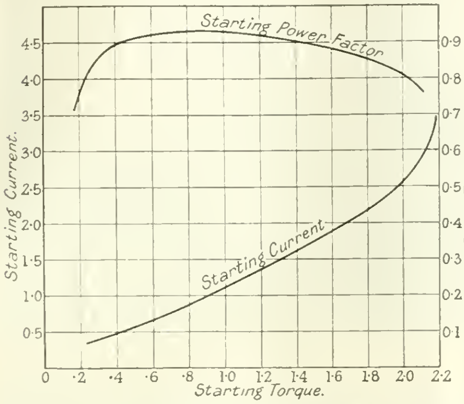

Fig. 5.—Cascade Self-starting Synchronous Motor. Starting Characteristics of Standard Machine. 450 b.h.p., 500 revs. per Min., 3,000 volts, 50 cycles. Power Factor, 0·7 Leading.

Before this machine was put in, the kilovolt-ampere loading of the generators was such that it would have been only possible to add another 250 b.h.p. in induction motors to fully load the generators. By installing a synchronous machine it has been possible to add 450 b.h.p. to the circuit and still leave something in hand in the generators. With this type of machine it has not been found possible to obtain any trace of hunting or phase-swinging.

Two-speed Synchronous Motors.

The self-starting synchronous motor starts as an induction motor with only two-thirds of its poles. It is therefore capable of being run with its slip-rings short-circuited as an induction motor at a speed 50 per cent. above synchronism. Such a machine has many advantages, especially when designed for slow speeds, where the power factor would be low at the second speed as an induction motor. By running the machine as a synchronous motor at its second speed it is possible to use a frame of small diameter, and for this and other reasons this machine meets the condition imposed by the new problem of the electrical propulsion of ships. The torque-speed characteristics of ship propulsion motors are very similar to those of fan motors. Besides the driving of fans, these motors can be used in connection with air compressors, &c., and, if desired, the power factor at full speed can be raised to unity by connecting a phase advancer to the slip-rings, thus giving unity power factor at both speeds.

Self-Paralleling Generators.

These machines are the latest development of the cascade system. They differ from the synchronous motor in their rotor windings, which are of the plain type, shown in Fig. 2. The stator windings are generally of the same type as used for the synchronous motor, but separate windings for the alternating-current and excitation circuits are sometimes preferable. The generators are excited and run up to speed, and are then connected to the bus bars without the use of any paralleling gear. These machines can be wound for 12, 18, 24, 30 and 36 poles, &c., and are very suitable for use with internal combustion engines.

Single-speed Motors.

The starting torque and speed of these motors are under complete control by regulating resistances connected to the stator "tappings." The rotor winding is completely short-circuited, so that the machine is practically a squirrel-cage motor, but behaves like a slip-ring motor, except that the rotor voltage at standstill is very small; the cascade machine is also quite stable at stand still, and starts without any jerk.

Two and Three-speed Motors.

These machines have a wide field of application—*e.g.*, in collieries and steel works for driving air compressors, ventilating fans, rolling mills, hydraulic pumps, &c.; they are hand controlled, or the speeds are changed automatically by means of contactor gear. Hydraulic pump motors are frequently automatically controlled, and in one Welsh steel works two-speed pump motors are so controlled without any switch gear in the stator circuit.

Rolling-mill Motors.

Recently there has developed an increasing demand for two-speed motors for driving non-reversing rolling mills, and machines have been installed and are in course of manufacture in sizes varying from 150 b.h.p. to 1,000 b.h.p. The speeds are in the ratio of 3 : 2. A typical example is a motor for a French steel works rated at 800 b.h.p. at 110 revs. per min., and 534 b.h.p. at 73·5 revs. per min., the number of poles being 48 and 72. The machine is wound for 3,300 volts, 50 cycles, three phase. Omitting the losses in the slip resistances, the efficiencies of the motor at full and second speed are 91 per cent. and 86·5 per cent. respectively.

Cascade Winding Engines.

Two-speed motor control with alternating currents is analogous to series-parallel control with direct currents, with the added advantage that the main circuit is not opened when the connections are changed. A winder is accelerated in two stages which dovetail into one another; at starting, the slip-ring circuit is open, and the controlling resistances are connected to the induction circuit of the stator. This gives the cascade coupling, and the winder accelerates to two-thirds speed. During the second stage, resistances are connected to the rotor, and the second stator winding is opened. By gradually short-circuiting the resistances the winder runs up to full speed. The control is preferably automatic, but may be by hand for small winders.

For a given kilowatt input the motor connected in cascade develops approximately 50 per cent. more torque than it does when connected to resistances through the slip-rings. For winders for moderate depths the peak is 25 per cent. to 30 per cent. less than that of a similar winder driven by a straight induction motor. The units consumed per wind are also reduced. In the original Paper the author works out a simple method of calculating the wind for a two-speed winder. The following particulars for two winders are of interest:—

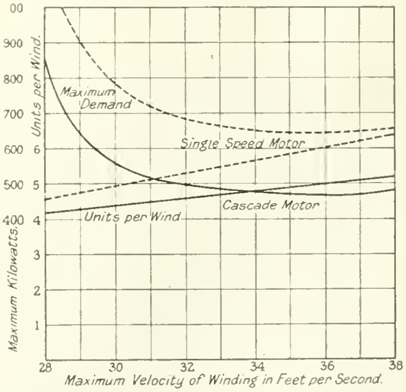

Fig. 6.—Winding Engine. Capacity, 2 tons per Minute. Depth of Wind, 1,200 ft.

Type of motor.	Kilowatt.			Kw.-seconds input.				Units per wind.
	Accel.	Steady	Braking.	Accel.	Steady	Braking.	Total.	
2-speed ...	504·9	300·9	136·1	8,870	6,500	1,460	16,830	4·68
1-speed ...	690·1	300·9	189·0	9,870	7,530	2,020	19,420	5·4

The two-speed winder takes a peak load 27 per cent. less than that required by a one-speed winder, and the units per wind are 14 per cent. less.

The losses in external resistances are for the one-speed motor 4,935 kw.-seconds, and for the two-speed motor 2,890 kw.-seconds, part of which represents the loss in the second stator winding. The figures calculated for this winder have been plotted in diagram form in Fig. 6.

Some Recent Conveying Machinery.

Interesting Applications of Electricity to the Handling of Materials.

When money is spent on labour which is employed in moving material from one place to another it is obvious that the material handled is not increased in value, and that from the commercial point of view the less money spent on this particular service the better. In the old days when manual labour was cheap it was from this point of view better to employ men to perform handling operations rather than to tie up capital in installing expensive and often inefficient machinery. As time has gone on, however, the cost of labour has increased and machinery, if it has become no less expensive, has certainly become very much more efficient. It may, therefore, be truthfully said that economy is the underlying reason nowadays for the introduction of all machinery, and there is certainly no sphere in which machinery is so important as in that which is used for the handling of materials.

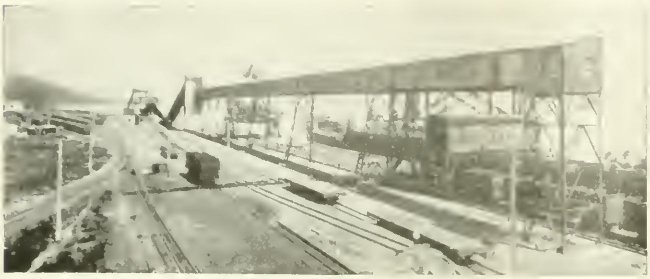

Fig. 1. Tripper Conveyer and Gantry at the Durban Coal-Handling Plant.

In what follows we may refer particularly to some interesting applications of the belt conveyer which have recently been manufactured and put to work by the Fraser and Chalmers' Engineering Works of the General Electric Company.

This firm have found this system of conveying the most economical when conditions are favourable. As is to be expected, however, this maximum economy is only obtained when the best material is used. The belt they supply for ordinary conditions is composed of cotton and rubber, the former of these materials supplying tensile strength and the latter the wear-resisting qualities. In selecting belts for this class of work great care must be exercised to see that no poor quality rubber is used. To do so, though it saves a little in the first cost, gives rise to great troubles later on. Fortunately, there are satisfactory means of testing the quality of rubber applied to conveyer belts and the details of these may be shortly referred to. The adhesion of the top cover of rubber to the first ply of duck is a measure of its ability to resist blistering or peeling off. This can be tested by taking a strip of belt, opening up the top cover and measuring the pull required to separate the rubber from the duck. It should take a pull of at least 25 lb., applied for one minute, to pull 1 sq. in. of rubber from a good quality belt, while a pull of as much as 50 lb. is often realised in practice with high-class material. The ability of the rubber cover to resist abrasion can be tested by cutting a strip of $\frac{1}{8}$ in. square in section and measuring the elongation and ultimate strength before breaking. The same quality can also be tested by means of a sand blast. The third test, which has to be applied, is to find the resistance to the friction between the various plys of duck to prevent the plys separating.

Another important point in connection with the manufacture of conveying machinery is the proper design of the idlers so as to reduce the wear and friction to an absolute minimum. It is necessary for this purpose that the idler should have all its rollers placed on the same transverse centre line and arranged so that they fit closely to the natural curve of the belt. To ensure this a special five-shaft idler known as the Robins Patent Troughing Idler has been designed at Erith. This idler has all the pulleys in the same vertical plane and it is consequently possible to give it an internal grease lubrication from end to end, while it is claimed for it that it is adjustable for the proper training of the belt, that it does not injure the belt, and that it readily fits the natural curve of the belt.

One of the most important applications for which machinery can be employed at the present is in the handling of coal. This, fortunately, is an easy material to handle compared with ore, phosphate or stone, but care must be taken that it is not broken. To fulfil this condition the use of the rubber belt offers decided advantages, for once on the belt there is no further movement of the coal until the point of discharge is reached, and as the coal is delivered in a thin continuous stream at any point a shoot can easily be devised to which it is delivered from the belt without any drop whatever. Fig. 1 illustrates part of a coal-handling plant which has recently been designed and constructed for use at Durban in which the conditions which we have outlined above are carried out. It is capable of discharging from 200 to 1,000 tons per hour.

The installation consists of four essential units: the dumper, by means of which the coal trucks are discharged into a large concentrating pan with a capacity of 150 tons, and capable of dealing with 75 ton trucks; an inclined belt conveyer which receives the coal from the pan and lifts it up an incline to a second band conveyer, which runs in the elevated gantry shown parallel to the quay wall, and which feeds by means of a tripper on to a hinged telescopic band conveyer mounted on a travelling tower. This last conveyer can be fed with coal in whatever position it may be and it discharges the load into the hold of the vessel.

The inclined belt conveyer is 230 ft. long and 48 in. wide, and takes the coal up an incline of 20 deg. from the concentrating pan to an intermediate tower. At the intermediate tower the coal is discharged into a three-way shoot from which it can be fed either direct to the travelling tower or to the tripper conveyer running parallel to the quay front. The tripper conveyer belt is 525 ft. long and 48 in. wide. It runs parallel to the quay wall and discharges the coal into the hopper of the travelling tower. The principal object of the travelling tower is to support the telescopic hinge belt conveyer and the telescopic anti-breaking shoot. The shortest length of the band from the supporting trunnion to the centre of the head pulley is 55 ft., and when racked out to the farthest position it is 77 ft. It is capable of delivering coal at a maximum height of 60 ft. above the water line, and owing to the telescopic arrangement, it can deliver at a distance varying from 8 ft. to 30 ft. from the edge

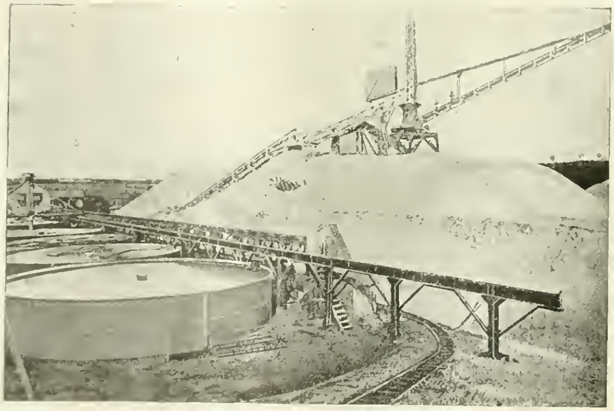

Fig. 2.—Stacker for Tailings from Gold Mines, Ripio and other Wastes.

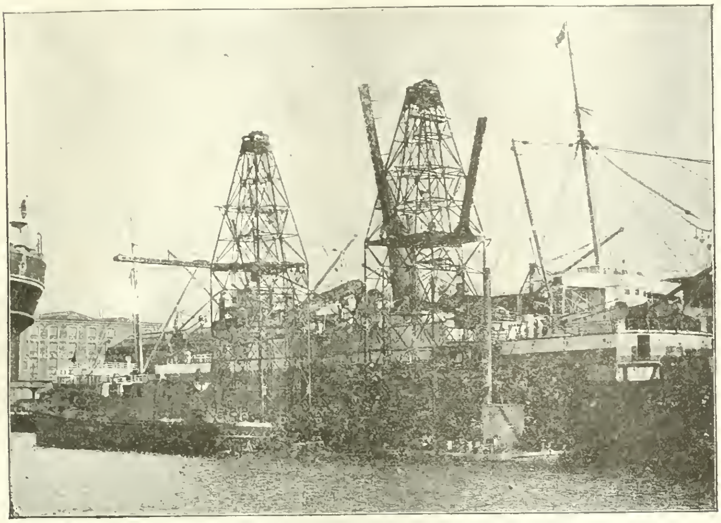

Fig. 3.—An Example of Modern Coal-Handling Plant.

of the quay wall. It has a travelling speed of 80 ft. per minute. The whole of this plant, except the coal-dumping plant which is operated from below, is controlled from one cabin at the top of the travelling tower, and the whole of the conveyers are, of course, electrically driven, seven motors being required to work all the movements of the travelling tower.

Another interesting machine is that known as a stacker, which has been designed for use on the Rand for forming dump heaps of waste materials. This arrangement consists essentially of an inclined belt conveyer mounted upon a revolving tower which is fixed on a temporary tresseling. Heaps can thus be formed on all sides for storing material. The last conveyer of the system can revolve about 300 deg., and this serves the purpose of building the waste heap ahead of the supporting structure. This is the cheapest method of disposing of large quantities of waste and is now largely used in modern gold mines.

An interesting example of machinery for handling coal which has recently been installed for the British Government is shown in Fig. 3. This was provided to unload colliers and operates at a total cost of ¾d. per ton, including labour and power. This cost, compared with that at another port in the English Channel where coal is taken from colliers by baskets at a piece rate of 1s., and again from the store to the railway by the same means at the cost of another 1s. shows what large savings can be effected by the use of modern machinery.

Fig. 4 shows another method of handling coal which has been supplied by Fraser & Chalmers' Engineering Works to the British Admiralty. It illustrates one of four electrically-driven grab transporters with a capacity of 100 tons of coal per hour. This method of unloading coal costs about ¾d. per ton, including the wages of the driver and the cost of current. A further advantage of this method is that the coal can be stored to a very much greater depth than when handled by a bucket. As an instance of this it may be stated that whereas coal is normally never stacked in British dockyards at a greater depth than 18 ft. to 20 ft. when buckets are used, it is constantly stored to as much as 34 ft. when transporters and grabs are employed. This means an increase in the capacity of the store ground of nearly 100 per cent. Rather contrary to expectation it has been found that heating does not take place at this large depth, so that the method is obviously advantageous.

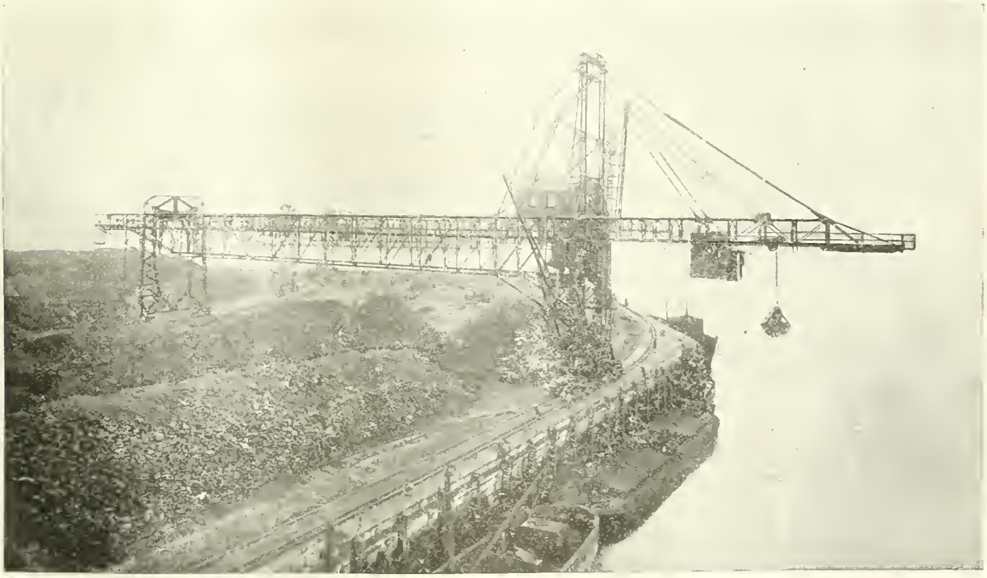

Fig. 4.—Coal Grabs at an Admiralty Dockyard.

Defects in Gas Works Electrical Plant.*

By E. DAVIES.

The question of electrical motive power in gas works has occupied so much attention recently that a few jottings on actual gasworks experience with same may be of general interest. In large gas undertakings, electrical motors of all types and makes are met with, the reason for this being that many gas plant contractors recommend the goods of the electrical firms with whom they deal, unless the gas engineer specifies any particular make.

The majority of electrical motors have constructional faults—even those supplied by the leading makers—which those responsible for their successful running soon discover. Referring to these briefly, there is the motor that has its end covers secured only by a slight overlap of the washers, the set-screws that pass through the latter being attached to the body of the motor casing, the result being that if the armature shaft has any tendency to seize in the bearing the whole of the end cover revolves, and may frequently be found with its oil well in the upside-down position and the oil all run out. Another make of motor has its brush-holders fastened to beechwood blocks, which shrink in retort-house temperatures and cause the carbon brushes to vibrate on the commutator instead of making firm contact.

Motors that have a field coil on the bottom prove troublesome, as any oil getting inside collects around the coil and saturates the insulation. Totally-enclosed motors, for dusty atmospheres, may frequently be seen in hot weather with the access doors open and muslin thrown over to prevent overheating. Semi-enclosed motors are also unsatisfactory in a retort house, as the fine dust invariably gets through the gauze netting.

One electrical firm of repute supplied an 8 h.p. motor, for driving a push-plate coal conveyor, to a municipal gasworks, the armature of which had a commutator only 1½ in. wide. The overheating was so intense that the interior of this motor was entirely destroyed by fire on two occasions, after which the insurance company refused to continue its insurance until its construction was altered. Many makers allow so little margin of clearance between the revolving armature's coil end and the brush terminals that these two points get fouling each other when the armature shaft gets the slightest increase of end play through wearing into the bearing bushes, and a careful surveillance is necessary to prevent this occurring. Electrical motor bearings in many cases are circular gunmetal bushes of only ¼ in. thickness, and this does not permit of a deep countersink for the point of the set-screw that has to secure them and prevent rotation and end movement, and instances have occurred where the tightening of the set-screw has bulged the bearing and caused the shaft to seize. This method is one that the makers could improve upon with advantage.

One of the greatest disadvantages in a gasworks with electrical plant is the delay when an electrical fault has to be located, as it may take an experienced electrician hours to trace it, and yet require only a few minutes to put right when found. Another source of unreliability of electricity is when reversal of polarity occurs through the slowing up of an engine or other causes, and prevents the generating sets being run in parallel. The writer has a vivid recollection of an experience, in the early days of the war, when a firm of gas plant engineers were installing a new electrically driven charging machine and coal handling plant, which necessitated one of the existing generating sets being taken out and a more powerful one put in its place. When the latter was put into commission, it was found impossible to run the remaining existing sets in parallel with it, each attempt to do so being accompanied by a reversal of polarity, and for some days, on account of this, the coke-screening plants, instead of being run as a continuous day load, could only be worked in the intervals between the retort-house draws, and the supply of graded coke was restricted in consequence.

Electrically-driven gas-boosting plant has caused grave concern at times, as, in the event of a fuse blowing, the sudden drop from high pressure to the district-governor maximum pressure delivery is naturally very pronounced and a source of consumers' complaints; and if any naphthalene trouble is occurring in the district main it may, without warning, overload the motor and blow the safety fuses. In a municipal gasworks in the Midlands a boosting plant obtained its power from the adjacent corporation electrical station, but during the war the demand for power for the district exceeded the supply, and the current to the gas department had occasionally to be cut off at the critical period when the latter had to meet their peak load. It will be obvious from these remarks on boosting plant that for reliability in the distribution department electricity cannot compete with the steam turbine as a prime mover.

Of course, in the case of a telpher an electrical drive is inevitable; but in this there is much room for improvement, as in the event of a fault taking place in the wiring, owing to all the main leads being installed under the floor of the telpher-cab, it necessitates the removal of the steel fire-shield plate and then the wood cover, before these can be examined, and where only a single telpher is in commission, it may require to be moved by hand labour the whole length of the track ere access to these hidden wires can be obtained. Finally, it should always be borne in mind that there is the ever-present risk of fire with electrical plant in a gasworks.

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* From the "Gas World."

The Protection of Alternating Current Systems Without the Use of Special Conductors.

We give below an account of the discussions which took place at Birmingham and Glasgow on Major K. Edgcumbe's Paper on this subject. An abstract of the Paper appeared in our issues of February 20 and 27.

DISCUSSION AT BIRMINGHAM.

Mr. G. Rogers said the author deprecated the use of a fuse shunted solenoid protection. For a simple circuit in which a discriminating time lag was not required, this type of protection was the simplest available, and was perfectly satisfactory in operation. Where the fuse shunted solenoid could not be used the induction pattern inverse time limit overload relay with separately adjustable current and inverse time settings was the most satisfactory instrument to adopt. Overload relays should be put in circuit at both ends of the feeder if it was possible for current to pass through the feeder, from either end. This provided a complete system of protection, as good as that suggested by the author. The protection of parallel feeders with differential reverse relays was open to the objection that there was always the danger of an unbalanced load in the feeders. It was also quite possible for parallel feeders to be unequally loaded to an amount beyond the control of the relay adjustments. In the case of two feeders in parallel, it would be quite impossible to test the relays under working conditions without both feeders being out of service. Fig 15 in the Paper was interesting, but in the event of one of the feeders from the generating station being tripped out due to a fault the reverse power relays on the inter-connector between two super stations would have to carry the full-load current to the sub-station. It would, therefore, be necessary for the setting of the reverse power relay to be very high.

Mr. W. Wilson did not enter a defence for the common porcelain-clad fuse. But such a fuse-wire gave under certain conditions a time-curve of surprising regularity. The solenoid and dash-pot pattern referred to by the author only gave an approximate protection, for the plunger did not begin to move until the actual overload had occurred, irrespective of the state of the cables. The thermal relay would give the same protection as the fuse, and was much simpler. At the same time, both fuses and circuit breakers gave excellent adjustment.

Mr. R. G. Jakeman, referring to Fig. 14 in the Paper, said if the fault occurred when the interconnector was-lightly loaded, the full overload current must flow into the fault before the relays would act. The author stated that the circulating currents between two machines in parallel due to hunting were very much out of phase with the voltage. Actually, however, these currents were practically in phase with the voltage, since they represented the synchronising power.

Dr. G. Kapp said that engineers would be pleased to learn that protection could be obtained without the use of pilot wires. The author's methods had the merit of simplicity, but did not touch on the protection of machines from the heavy blow which the winding received in the first moment of an explosive short-circuit. The machine must, therefore, rely on the protection due to either inherent or outside inductance. To a certain extent this was also the case with heavy feeders. Grading which had to be done to the fraction of a second could not be very definite. If a longer time were allowed we must give up any idea of using the circuit-breaker to save machines from the first rush of a short-circuit current and adopt the method of added inductance. If, however, apparatus was installed at the delivery end of the lines to inject leading kilovolt-amperes the power factor was raised, which gave something very near absolute protection. The question was what kind of source of leading kilovolt amperes to employ. Condensers or over-excited synchronous machines would do as well. The loss in condensers was almost negligible, but they were expensive. Synchronous machinery was cheaper, but the loss of energy was heavy; both had the disadvantage that the amount of leading kilovolt-amperes injected was independent of the load. What was wanted was something which would throw into the system an amount of leading kilovolt-amperes in some proportion with the load. If the consumer used small motors or even large squirrel-cage motors static condensers were the only possible means of his obtaining in his own plant a good power factor. If he had large slip-ring motors he could use a phase advancer, and although his power factor at light loads would not be so good as with condensers his power factor at full load or overload would be in the neighbourhood of unity.

Mr. W. Brew thought special precautions would be advisable either in the design or location of the leakage transformer, illustrated in Fig. 2 of the Paper, to shield it from stray magnetic fields. The simplicity of the arrangement illustrated in Fig. 2, as compared with that in Fig. 3, was greatly in favour of the former. In connection with the protection of parallel feeders illustrated in Fig. 8 and Fig. 9 of the Paper he hardly thought the method suggested could be regarded as a general solution of the problem. The most important feature of a relay control system should be its power to indicate clearly when and where a fault had occurred. Under the mental stress of a bad shut down, apparently logical conclusions may be quite misleading, and this was especially likely to be the case where the seemingly erratic action of a number of instruments and circuits had to be interpreted. A good deal of expensive apparatus had been installed and "tied up" in the past on this score alone.

Mr. A. T. Thurman said the arrangement shown in Fig. 16 of the Paper for the protection of a system comprising two generating stations and four sub-stations was satisfactory providing the inter-connector between the generating stations was large enough to transfer load from one to the other, in case of trouble at either station. With regard to the checking of relay settings, he had found the method in Fig. 26 to be quite satisfactory, but the initial test after the relay had been installed in its working position should be from the primary side of the current transformer; every connection was then tested from the transformer to the relay practically under working conditions.

Mr. J. Morton said the independent supply for the pressure element of reverse relays might easily be obtained by installing a unity ratio potential transformer across a reactance, the voltage obtainable being governed by the current flowing in the reactor, and, further, under faulty conditions the normal current might be increased, thereby giving a proportionate increase in the pressure across the terminals of the potential transformer with a resultant increase in power for the satisfactory operation of the relays. At the present time it was possible to obtain turbo-alternators having high internal reactance, sufficient to take care of the alternator on short-circuit. The inherent reactance would have no effect on the amount of current which would flow from the 'bus bars into such a fault developing near its terminals. Some advantage might, therefore, be gained by putting half the total reactance in the machine itself and the other half external to the machine.

Mr. W. E. Groves said the four cardinal points mentioned at the commencement of the Paper required a limitation of the number of the protective devices employed. The layout which was described was more applicable to undertakings of moderate size than to large systems. Major Edgcumbe mentioned that the Merz-Price system operated in water-tight compartments. But the system could, of course, be extended to cover any mains or gear. It was illogical to protect cables, and leave the more vulnerable switchgear unprotected. When a ring main was open, and sections of mains between consumers were in simple series, it would not make for certainty of supply to employ graded protective devices throughout where many consumers were connected to the ring. Provided the best cables and switchgear were put in these should be given a chance and protection should be limited to the supply ends and the consumer's installations.

DISCUSSION AT GLASGOW.

Prof. F. Baily said he agreed with the view that protection devices worked from the cable itself had distinct advantages over separate cables running alone for the reason that the small cables which formed the protective device were more apt to break down than the big cables they were intended to protect, though they were not subjected to the high voltages of the latter. There was more likelihood of the protective devices breaking down on overhead lines.

Mr. C. W. Marshall said he thought it advisable to stake everything on clearing faults before they had time to develop between phases, and the most obvious way of doing this was by increasing the speed and sensitiveness of relays and switches, particularly in the case of synchronous converting machinery. He did not share Major Edgcumbe's regard for the induction relay, as the jewels and pivots gave trouble, and the time calibration was liable to alter due to the magnetising action of the alternating field under short-circuit conditions. Unbalancing to 5 per cent. could never be tolerated, and it was easy to balance to within 0·5 per cent. A fair degree of accuracy could be obtained with compensating induction watt-hour meters without the use of compensating devices. If the meter was badly designed no amount of compensating would do it much good.

Mr. A. E. McCall said the methods of the author had been generally found wanting when applied to larger and more involved systems. The author did not refer to combined leakage and unsymmetrical loading devices which gave instantaneous protection against faults between any two phases in addition to ground faults. There was room for an overload relay having a double characteristic. Devices had been developed which would be operative only in the faulty section. They were agreed that it was not safe to interrupt the protective gear circuits, but it was equally disastrous to break the instrument circuits where transformers with double secondaries were employed. The maximum feeder arrangement could be protected by interlocked discriminating relays. He asked what the percentage bias of the arrangement described in the Paper would be at 30 times full-load current with the potential at 2 per cent. of the normal. Biased differential systems of generator protection were available to operate with less than 2 per cent. fault current. Systems of generator protection had recently been developed employing directional relays. The method of earthing shown in Fig. 20 of the Paper was preferable to earthing the neutral point of one generator.

Mr. E. Seddon said protection was bound up with the design of switchgear. Considering the short-circuit currents in large power circuits to-day, it might be better to limit the flow of current by opening a circuit-breaker across which would be connected a reactance, and afterwards disconnecting the faulty circuit by a second switch placed next to the 'bus bars. This switch would also operate direct on single-phase leakage. He preferred the fuse shunted solenoid to the mechanical movement of dashpots. Closed feeder protection was best arranged by protecting each closed feeder independently either by the Merz-Price or split conductor protection. On tests with carbon resistances the carbon became heated, and the powder was blown out of the slots. There was also the question of dust collecting.

Mr. A. P. Robertson said he agreed that the circuit should be opened as early as possible when there was a fault. He thought they should concentrate on getting the maximum speed of opening where there was much synchronous machinery.

Mr. A. Henniker said the fuse time limit was the most satisfactory of all. The two main factors were maintenance of continuity of supply and the guaranteed cutting out of faulty sections. He would like to know if in putting down a new system the author would put in relays or some of the more recent systems of balanced protection.

Reviews.

An Enquiry Concerning the Principles of Natural Knowledge.

By A. N. Whitehead, Sc.D., F.R.S. (London: Cambridge University Press.) Pp. xii.+200. 12s. 6d. net.

The author, in his preface, points out that: "Modern speculative physics, with its revolutionary theories concerning the natures of matter and of electricity, has made urgent the question, What are the ultimate data of Science?" The critical investigations of the nineteenth century into the nature of mathematics and the foundations of geometry have done much to clear the way to such an inquiry, and the modern theory of relativity has opened a new world of thought as to the relations of space and time to the ultimate data of perceptual knowledge. The volume before us is largely concerned with providing a physical basis for the views which have so emerged, and, therefore, has to deal with geometry, not as an abstract science based on one or other set of hypothetical premises, but as a physical science in which may be sought an answer to the question, How is space rooted in experience? The principle underlying the whole investigation, and which is substantiated by it, is that the scientific concepts of space and time are attainable as the first outcome of the simplest generalisations from experience, and that they are "not to be looked for at the tail end of a welter of differential equations." The theme of the whole enquiry is the coherence of the known, and the perplexity which it aims at unravelling is as to what it is that is known. Nature is therefore regarded solely as the object of perceptual knowledge, so that the argument is always physical, never metaphysical.

Until quite recently, a physical explanation has invariably meant one expressed in terms of distributions of material, such as matter, electricity, or ether, throughout a space in itself without activity, defined by Euclid's axioms, a pure geometrical abstraction, conceived as a manifold of discrete points, at a number of discrete durationless instants of time, which time is, moreover, supposed to flow equably in measurable lapses. The difficulties of such a statement were recognised in very early times, *e.g.*, the paradoxes of Zeno and the Electic School. And there is clearly no room left for such essential physical quantities as velocity, acceleration, momentum and kinetic energy. And the instantaneous representation of an atom, a molecule, or even a material body, would be nothing more adequate than a distribution of electricity. For change is essentially the importation of the past and the future into the immediate fact embodied in the durationless present instant. The ultimate facts for science cannot, therefore, be found at durationless instants, which do not correspond with any possible observations, and, implicitly, scientific theory is shot through and through with notions which are frankly inconsistent with its explicit fundamental data.

The separative effect of the traditional conceptions present physical unities, through their appearing to us as in time and space, as discrete aggregates. The discreteness is masked, in the case of temporal separation, through sense evidence of continued existence in time; but we always think of a body appearing to be extended in space as divisible into parts, our only warrant for their interconnection being the sub-conscious assumption of absolute space. But if we accept the philosophical principle of the relativity of space, that its properties are merely relations between things said to be in space, we are left with an instantaneous space corresponding to each instant, without any correlation existing between them and without any means of observing them.

The fundamental assumption elaborated in this volume is that the ultimate facts of nature, in terms of which all physical and biological explanation must be expressed, are events connected by their spatio-temporal relations, and that these relations are in the main reducible to the property of events of containing, or extending over, other events. Although in perception no event exhibits definite spatio-temporal limits, it is assumed that such limits may be assigned in thought. The most general type of event is a *duration*, representing the whole continuance of nature now present; it is a temporal slab of nature. On the Newtonian theory of relativity, every pair of durations would be extended over by larger durations, but this is not necessarily the case on the electro-magnetic theory of relativity, so that the latter is the more general, and is therefore the one adopted. A set of events is called an *abstractive class* when (1) of any two of its members one extends over the other, and (2) there is no event which is extended over by every event of the set. The members therefore constitute an infinite convergent series forming a route of approximation towards an ideal simplicity of content—an event-particle. Every space and time element, as conceived in science, is an abstract entity formed out of the relation of extension, in association with the relation of *cogredience*—the property of an event of being unequivocally *here* throughout its associated duration—by the method of extensive abstraction—developed in detail by the author—a determinate logical procedure which is simply the instinctive procedure of habitual experience systematised—depending on certain empirically verified properties of extension.

Hence there emerge three types of meaning which can be given to the idea of space in connection with external nature, determined by their respective geometrical systems. (1) The four dimensional time-space of Minkowski. (2) The three dimensional instantaneous spaces in the moments of any time-system. The observed space of ordinary perception is an approximation to this exact concept. (3) The three-dimensional space of any time-system which may be called a timeless space in that its points have no special relation to any one moment of its associated time-system. This is the space of physical science.

There emerges also a general system of kinematics containing an absolute constant which may be positive, negative, or infinite, the meaning of which is seen to be the comparability of space-units and time-units. The formally possible zero value is excluded because the results are obviously in contradiction to experience, and the other three alternatives prove to be the familiar hyperbolic, elliptic, and parabolic types of kinematics corresponding respectively to—the theory of electro-magnetic relativity: a system in which the distinction between space and time finds no expression in the formulæ for measurement relations, and may therefore be supposed non-existent; the theory of Newtonian relativity. The author rejects the elliptic kinematics as though logically possible, not in his opinion corresponding with the external world of events as we know it. Moreover, the electro-magnetic equations lose their invariant property.

It is an error to ascribe spatial or temporal parts to objects, except in a derivative sense, from their relations to events, objects having no necessary temporal and spatial relations essential to their individual ties. The atomic properties of nature reside in objects, while the continuity of nature is to be found in events. The conception of material, transmission and causation are introduced by the consideration of objects: for these concepts express certain relations of objects to events, but the relations are too complex to find complete expression in such simple terms.

The work is one which no student of the physical relativity theory can afford to neglect, and it should contribute largely to the elimination of the "bizarre" results and discussions of some of its most notable exponents.

G. W. de T

A History of Chemistry. By F. J. Moore, Ph.D. (London: Hill Publishing Company.) Pp. xiv. 292. 12s. 6d.

The present volume is the outgrowth of a series of talks which Prof. Moore has for several years given to his students at the Massachusetts Institute of Technology. It is comprehensive, for it starts with the ancient philosophers and ends with radioactivity.

The value of such a work depends not so much upon historical facts but upon showing how the science of chemistry has been gradually evolved, and how false theories have from time to time been discarded. It is of great value to realise how mistaken views have arisen. This the author shows in an interesting and readable way. Little attention has been paid to the thorny subject of priority. The aim has been to emphasise only those facts and influences which have contributed to make the science of chemistry what it is to-day. Thus, in later work, the space given depends not on whether the work itself was of value but whether it contributed a new fundamental idea. To some chemists this may appear disappointing, but we think the basis is sound.

Correspondence.

THE INSTITUTION AND ITS COUNCIL.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am delighted to see your Leading Article this week on the above subject, and sincerely hope it will help to bring about the necessary reform which you suggest, but past experience leaves one somewhat in doubt.

Those who criticise will at once be met with the reply that it is open to any group of members to nominate other candidates; but those of us who have adopted this course in the past are aware of the difficulties, unpleasantness and not altogether successful efforts to oppose "official" nominees of the Council. This trouble is not confined to the I.E.E., some of us have experienced it in the I.M.E.A.; and, according to the articles of association of the British Electrical Development Association just issued, it looks as if a similar state of affairs is being catered for in that association. Even our premier institution—Parliament, to wit—is not free from the curse of what I have termed on many occasions "The Old Gang" running the show, and it is a difficult job to overthrow the "coupon candidates," be they I.E.E. or any others.

Your suggestion that grumbling might give place to action is useless so long as those who grumble will not act together. In my humble endeavours at organisation on these sort of affairs I have found many quick to grumble but slow to act, or even follow a lead.

That is the fault of the middle and professional class—they have no "guts" or decisive action about them; and that is what I admire in the Labour Party—they do vote and act solidly "Yes or No," and that is what the former group never seem capable of doing. The only reason I can give for this sloppiness is that each and every one is expecting some crumb of reward to fall from the lap of the gods, and they are afraid to do otherwise than grovel, for fear of falling into disfavour. No doubt there is some justification for this timidity of action, because, if threats had been of any avail, I would have been "off the map" years ago, because I say what I think and act accordingly. As, however, I do not belong to the "you scratch my back and I scratch yours" fraternity, I shall continue to protest against, and do all I can to oppose, the "closed ring," whether it be industrial, professional or institutional.—I am, &c.,

West Ham,
April 12.

Fredk. W. Purse,

The Electrician.
FRIDAY, APRIL 16th, 1920.
Price ONE SHILLING. By Post 1s. 1d. Ann. Sub.: U.K. 52s., Abroad 54s.
Editorial and Publishing Offices:
8, BOUVERIE STREET, LONDON, E.C.4.
Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

Communication in War.

One of the fundamental necessities of a modern fighting force, if success is to be obtained, is some means, not only of knowing what the enemy is doing, but of keeping in touch with one's own units, so that orders and reports may be sent accurately and expeditiously from the higher to the lower command, and *vice versa*. This intercommunication is equally necessary between the administrative departments, as among the fighting troops, in order that ammunition, stores and the hundred and one things that go to make up that unweildy and varied Cosmos, an army, may be successfully dealt with. This need has been evident in all wars, but it was more than ever evident in the Great War, when the enormous number of men involved and the great distances covered required that the most modern methods of intercommunication should be employed as efficiently as possible.

The Work of the Signal Service.

To perform this duty for a modern army is the work of the Signal Service, which is, indeed, almost an army in itself. In our own forces we know from the despatches of the Commander-in-Chief that this work was well done, not only by the male but by the female personnel, and equally by those whose business it was to operate a telephone under fire in a Forward Observing Post, as for those whose lot it was to work out methods for the improvement of wireless telegraph apparatus in some laboratory in cloistered England. But, as far as our own Army is concerned, we know little of the details of what was done and less of why it was done. This is a great pity, especially from the technical point of view.

As far as the American Army is concerned, however, the veil has been lifted to a considerable extent in the report of the Chief Signal Officer, Major-General George O. Squier, to the Secretary of War. We have been favoured with a copy of this report, which nominally deals with the work of the Signal Corps during the year ended June, 1919. In reality, it practically covers the operations of the American Signal Service during the war period, and makes a most interesting record of the way in which our latest knowledge in telegraphy, telephony and wireless telegraphy and telephony were used to forward the warlike aims of our Allies.

Great Technical Development.

As in other armies, the Signal Corps of the American Army was, when that country entered the war, a small body of specially trained men. To increase its personnel without reducing its quality, the wise course was taken of enlisting men from the American Telephone & Telegraph Company and the Western Union Telegraph Company, and of securing the services of the heads of those organisations, including such well-known men as Mr. J. J. Carty and Mr. F. B. Jewett, while Prof. R. A. Millikan, professor of physics in Chicago University, also gave his services in connection with the technical work research.

How important this technical work was will be gathered when it is stated that scarcely a single piece of apparatus that was regarded as adequate at the beginning of the war was to be found in use at the signing of the Armistice. Much of the work in connection with the necessary improvement was done in a specially-equipped laboratory at Little Silver, where it is hoped to make a permanent establishment. To give some idea of the equipment dealt with, it may be mentioned that over a million batteries were produced, and over 100,000 telephones for field use, while over 8,000 of one single type of wireless apparatus were made and sent to France.

Inter-Continental Communication.

One of the most important questions with which the Signal Corps had to deal was the maintenance of communication between the United States of America and the Armies in France. It was considered likely that the enemy would make an attempt to cut the cables, and, as a matter of fact, two cables were cut by submarines, though their failure was not serious, as, not being inter-Continental cables, alternative land lines were available. It was therefore determined to supplement the cables by the erection of high-power wireless stations, from which messages could be sent to similar stations in France, Italy and this country. This determination gave rise to some interesting problems which were successfully solved in the new high-power station erected at Annapolis. Other phases of the transatlantic communication problem were to be found in preventing the enemy from using our Allies' transatlantic electrical communications, and in sending messages in plain English to overcome the loss of time spent in coding and decoding. After a number of experiments, an apparatus was devised whereby a message written in plain English could be quickly enciphered, sent, and on reception presented on the deciphering machine in plain English. This is done as quickly as with an ordinary message, while the safety of the message is enhanced owing to a reduction in the number of those possessing the cipher.

Telephony in France.

On the telephone side equally interesting methods were adopted, and in spite of the difficulties of working in with the apparatus used in our own and the French Armies, it was decided to employ the latest types of apparatus, with the result that small gauge wire was successfully employed in conjunction with vacuum telephone repeaters, phantom circuits, multiplex telegraph printers and combined telegraph and telephone working. Over 1.700 miles of pole line were erected, and a system of 37,950 miles of wire covered the area from Le Havre to Bordeaux and Marseilles and from Brest to Chaumont. The technical details of the equipment used and the methods employed will be found in the report, and will be of great interest to "weak current" engineers.

It is stated in some circles that America alone won the war; but we have not given publicity to this report because we hold that opinion. We know of another Signal Service which did good work for a longer period and during more arduous times than did that of the American Army. Reports of their work must have been written, and they should be published, for, as we remarked a week or two ago, we learn by our mistakes, and we should like to know what these were. We know that an official History of the War is being prepared, but at the present rate of progress by the time it is published most of us will be under the sod, and, at any rate, the technical information will be out of date. We therefore suggest to the authorities that, not only for personal but for technical and scientific reasons, they should issue some official account of the advances made in telegraphy, telephony and other branches of electrical engineering as a result of the wartime experiences and conditions.

The Lighting of Display Windows.

The display window is one of the most efficient methods of advertising open to the retail trader. Through this medium his advertisement is always correctly timed and placed, because at the moment when the display is seen the person who sees it can most easily make his purchase. Moreover, the very fact that he or she is walking along a street of shops is, in many cases, fair evidence of a desire to buy. A large proportion of suburban marketing is done in the early evening when, for a large part of the year, it is necessary to use artificial light. It is quite evident that the effectiveness of the display at this period of maximum opportunity is chiefly determined by the effectiveness of the artificial illumination.

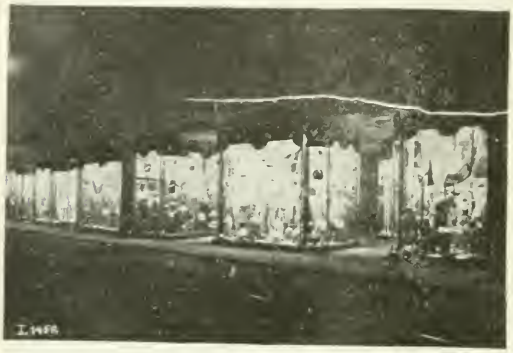

Fig. 1.—An Example of the Lighting at Messrs. Alldens Stores, Croydon.

In deciding what constitutes effective lighting in a display window two fundamental, but frequently neglected, principles should be borne in mind. One is that the light units themselves should be invisible, since, unless the trader proposes to sell electric light fittings, there is no object in making them the centre of attraction, as they are bound to be if fixed within view. The other principle is that all the light should be concentrated on the display, none being wasted on the pavement, or directed into the eyes of prospective customers. To light the pavement is not only wasteful, but it is also positively bad, as it reduces the contrast which should be maintained between the lighted window and its surroundings. To acknowledge the truth of these arguments is to agree that the only thoroughly effective method of lighting a shop window is by means of light units fixed along the top front edge of the window, and so arranged as to throw all the light down and back on to the displayed goods. Outside lamps must not, of course, be used.

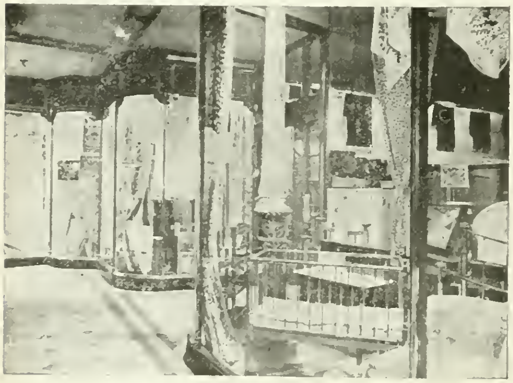

Fig. 2.—Another View at the same Shop.

A good example of modern lighting is provided by the recent installation in the windows of Messrs. Alldens' department stores, Croydon. Each light unit consists of a 100 watt Mazda half-watt type lamp in an X-ray window lighting reflector. These units, of which about 250 are used, are fixed along the top front edge of the windows, and are spaced about 3 ft. apart. The units are concealed from view by a narrow tapestry curtain. The X-ray reflector has a reflecting surface of mirror glass, so formed that the light is distributed uniformly over the floor and back of the window, without overflowing on to the pavement. In the manufacture of X-ray reflectors special corrugated glass blanks are coated on the outside with pure silver, which is thoroughly protected by several coats of elastic enamel. The X-ray reflector is an individual reflector for a single lamp, which is claimed to be more efficient and less expensive than troughing.

As may be judged from the untouched artificial light photographs which illustrate this article, the illumination in the windows is brilliant, uniform and comparatively shadowless, enabling every smallest detail to be seen with perfect ease and clarity. More important still, there is not the slightest suggestion of glare to distract or annoy the prospective customer. Another very attractive feature is the contrast between the brilliant windows and the darker street. By this means the effectiveness of the display is greatly enhanced. The general effect is somewhat similar to that secured on a theatre stage, where the art of arresting attention and of stimulating appropriate emotions by visual appeal is perhaps better understood than anywhere.

We are indebted to the British Thomson-Houston Company for the information contained in this article.

Gas Engines v. Electric Motors.*

The experience of an engineer in a factory in which electric motors are used is given in the following statement. Writing upon the amount of attention required by gas engines in comparison with electric motors, it is stated:

Motors, starters, switches and fuses all demand attention, like a gas engine, and have a happy knack of going wrong at the most awkward moment. One would think, when reading of motors, that they run for ever without attention—merely press a button and that is all; that armatures never need rewinding; that the wiring in the field never gives out; that if you are using brushes they, too, need never be replaced with new. If one has a dozen or more motors under one's care, one or another of the machines needs to be continually seen to, so that the amount of time and attention expended becomes, during the week, quite as much as for a gas engine. Far from feeling animosity to the motors, the writer would be the first to admit that, as regards cleanliness, ease of starting and room space, they are far ahead of gas engines, but when that is said that is as far as one can go.

When it comes to cost per hour per horse-power given off, the gas engine soon leaves the electric motor behind. To gain an idea of relative efficiency, it is useful at times to run the motor unloaded, and read the supply company's meter over a period of, say, one hour. It will usually be found that one-fourth of the current is being used to drive the motor alone, and the smaller the motor the greater the loss.

Now look at it from another side. It takes 746 watts to give 1 h.p., and the loss in wiring and to drive the motor brings it up to, say, 1,000 watts, or one unit, per hour, which at 2d. per unit for a nine hours day costs 18d. for every horse-power. In the case of a gas engine taking, say, 20 cubic ft. per hour per brake horse-power, 180 cubic ft. in nine hours at 4s. per 1,000 cubic ft. amounts to 9d. per horse-power, or just one-half of what it costs to get the same duty from motors.

Experience has shown that electricity is not cheaper than gas, hour for hour and horse-power the same. This experience is not a theoretical, but a practical working one, both with large motors driving main and countershafts, and also with independent and group driving of printing machinery. Ever since motors came under the writer's care he has made it his duty to see what the actual consumption of current in each motor, loaded and unloaded, really amounts to, and has checked weekly the time the machines have been running, and the current consumption. In his opinion many users of electric power would revert to the use of gas engines if the lack of space did not restrain them.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Practical Engineer" Electrical Pocket Book and Diary, 1920. (London: Technical Publishing Company.) Pp. clxii.+592. 1s. 6d. net.

"Wireless Transmission of Photographs." By M. J. Martin. (London: Wireless Press, Ltd.) Pp. xv.+143. 5s.

"Selected Studies in Elementary Physics." By E. Blake, A.M.I.E.E. (London: Wireless Press, Ltd.) Pp. xvi.+176. 5s.

"Wireless Telegraphy and Telephony: First Principles, Present Practice and Testing." By H. M. Dowsett, M.I.E.E. (London: Wireless Press, Ltd.) Pp. xxi.+331. 9s.

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* From the "Gas World."

Parliamentary Intelligence.

TRAMWAY CHARGES.

In the House of Commons on Monday the Tramways (Temporary Increase of Charges) Bill was read a second time.

In moving the second reading, Mr. Neal said the financial position of tramway undertakings, both municipal and company-owned, was such as to call for some relief. The 66 municipal undertakings showed an estimated surplus of £73,695, without making any provision for renewals and the arrears of renewals that had to be made good. Some of the undertakings were already a sore burden on the rates. There was something like £15,500,000 of capital invested in the 197 tramway companies, and the cost of meeting all priority charges and providing for renewals was estimated at £455,000. The Industrial Council decided that it was necessary that an increase in the rate of pay should be given to the employees of those undertakings, but they were quite clear that it was impossible to give effect to the recommendation unless power was given to the undertakings to increase the charges which were permitted by the Statutory Undertakings (Temporary Increase of Charges) Act of 1918. The present Bill abrogated the limitations contained in that Act, so far as they were referrable to Orders made by the Minister of Transport under that statute, and other methods were substituted. Powers were vested in the Minister to relieve the undertakings temporarily from onerous and unremunerative conditions which hampered their working, and he might make Orders authorising an increase of charges—in the case of municipalities with the limitation that they shall not make a profit in relief of rates, and in the case of companies such an increase as might be necessary to enable them to pay a reasonable return on their capital. The Minister would act under the advice of advisory committees to be set up and consisting of the Light Railway Commissioners and of members to be selected from the advisory panels established under the Ministry of Transport Act. But inasmuch as the matter was quite urgent it was desirable that the Minister should have power to act promptly. The Bill proposed that the Minister might make interim orders which should not have validity for more than six months, and that he should forthwith on making an interim order refer the matter to the Advisory Committee for consideration and report, so that a more permanent order might take its place. There was also a provision for review, either at the instance of the Minister, or at the request of the local authority or company concerned, or in the case of municipal undertakings of 20 ratepayers. The operation of the Bill was limited to 3½ years, *i.e.*, February 15, 1923. Both tramways and light railways would be within the scope of the Bill.

In the course of the subsequent discussion Sir E. Geddes pointed out that the request for increased charges came from 169 undertakings owned by public authorities, and 94 company-owned undertakings. There was no question of permanently increasing the share value of the undertakings. Whatever powers the House gave to any authority would lapse at the end of 18 months from August next. Without the Bill the undertakings could not get the money to pay the wages, and the men would go on strike because they did not get the recognised standard.

OVERSEAS TRADE CREDITS.

The House of Commons has sanctioned the proposal of the Government to authorise Government credits not exceeding £26,000,000 at any one time to re-establish overseas trade. In the course of the discussion it was pointed that the restrictions as to security were stringent and there was no considerable risk. Traders in this country had to make their contracts in European countries in face of very keen American competition, and it was essential that there should be a large credit to get the countries of Central Europe going so that they would work up raw materials on commission. The Board of Trade could limit the articles for which the advances were to be made to really essential articles. The scheme might also help us to get a trade footing in countries where we had not one before, and prove valuable later on when our trade with other European countries might be falling off. The United States had made a similar provision of one thousand million dollars.

EDUCATION ESTIMATES.

The estimates of the Board of Education for the year 1920-21 have been issued. The amount required is estimated at £45,755,567, an increase over 1919-20 of £12,983,004. The chief increase is on elementary education, which amounts to £12,000,000. The grants for training teachers are doubled and there is an increase of £117,500 for technical schools.

A more generous attitude towards scientific investigation is shown, the grants in aid of the various societies totalling £208,416, an increase of £81,442, while £518,298 is provided for scientific and industrial research. The amount allowed in 1919-20 was only £271,453, so that there is an increase of £246,845. The total of expenditure on university education is £[illegible]5,700, as in 1919-20. The amount allowed for universities shows a decrease of £304,000.

PUBLIC UTILITY COMPANIES BILL.

On the Report stage of this Bill in the House of Commons on Monday amendments were adopted to make it applicable to electricity supply, tramways and light railway companies. The Bill provides for the variation of the provisions regulating the raising of capital by companies carrying on certain statutory undertakings. For gas, water and hydraulic power undertakings the Board of Trade, and for electricity and tramway undertakings the Ministry of Transport will be the Government Departments whose consent will be required to the exercise of the powers

Legal Intelligence.

Assessment of Motors.

By a majority, the Glasgow Assessment Appeal Committee has allowed the appeal in a case selected for determining whether electric motors in use in factories and shops should be subject to local assessment. Mr. Alex. Walker, City Assessor, proposed this development in rating on the strength of the provision made in section 1 of the 1902 Act, which gives power to assess machinery for producing or transmitting "first motive power." About 2,500 appeals were lodged against his proposal, and the present appeal was a test case. The ground of the decision was that conditions of valuation statutes other than the Act of 1902, were not met in the Assessor's proposal to regard the subjects as rateable.

Mr. MacRobert, K.C. (for appellant, Mr. E. Watson), said the Glasgow rating authority were now, for the first time, going to assess ordinary motors in factories, and they were to do so under an Act which made provision for the assessment of first motive power. The extraordinary position of the Assessor was that when he went into a factory he said that the motor was a machine producing first motive power, but when he went into the power station he said the motors there were not machines producing first motive power that the boiler and the engine produced the first motive power in that case.

Mr. R. B. Mitchell, chief electrical engineer of the Corporation, stated that there were five motors in appellant's premises in question and they were used for driving mincing machines, refrigerating plant and a saw. In his opinion "first motive power" and "prime mover" were interchangeable terms. An electric motor could not be regarded as a prime mover. First motive power was power derived from one of the sources of energy in nature, such as fuel, water and wind. The boiler and engines in the Corporation electricity station used for producing or transmitting first motive power were already assessed.

In cross-examination witness stated that "first motive power" was not an engineering but a statutory term. First motive power was in the generating station and stopped at the coupling on the shafting at the generating station. After that it became second or third power. Electrical energy entered the motor, passed through it and was transformed into mechanical energy. If the tenant were vacating these premises the motors would be easily removable, and that could be done without interfering with any part of the building.

Mr. R. D. M'Coll, accountant, electricity department, said the principle on which the Corporation was assessed, by the railway assessor, for its power station was that they should be rated for boilers, steam pipes, engines or turbines as first motive power. The question of rating came up between him and the railway assessor at the time that the Act of 1902 came into operation, and the principle of the assessor's valuation was then defined. The assessor had not changed that view.

Prof. J. D. Cormack, Glasgow University, said that the words "first motive power" had no meaning for the engineer. The term used by engineers was "prime mover." In his opinion the wording of the Act "first motive power" was intended to mean "prime mover." First motive power in that sense was produced from some natural source of energy—coal, gas, water.

Prof. Magnus Maclean, Royal Technical College, gave similar evidence and appellant's case closed.

In support of the Assessor's case Mr. Walter Eckford, assistant assessor, Edinburgh, said that for the last 10 years they had entered in the valuation roll, in Edinburgh, subjects similar to those which the Glasgow Assessor now proposed to tax, and no opposition had been offered at any time to the assessment. They assessed all motors in works and shops, down to small motors of ½ H.P.

Mr. Simpson said that in Leith they had assessed power motors in works and shops for the first time last year.

Mr. Alex. Walker said that his action in proposing assessment of these motors was based on the 1895 Act, plus the 1902 Act, and all the other Valuation Acts since 1854.

The Clerk to the Committee, in communicating the decision to sustain the appeal, stated that the committee felt bound by the case of the Etna Iron & Steel Company *v.* the Assessor for Lanarkshire, but that they were not satisfied that the motors and their attachments were erections or structural improvements under the Lands Valuation (Scotland) Amendment Act, 1895, and they were of opinion that, apart from the Lands Valuation (Scotland) Amendment Act, 1902, the motors were not so fixed or attached as to make them heritage.

An appeal has been lodged against the decision.

Damage to Electric Supply Cables.

A case of considerable importance to electric supply companies and authorities was recently decided by Mr. Justice Bailhache. The City of London Electric Lighting sued the Improved Wood Pavement Company to recover £62 10s. for damage caused to the company's casing and cable. For plaintiffs it was stated that defendants were repaving the south side of St. Paul's Churchyard. Having removed the old paving, defendants were engaged in breaking up the concrete and one of their workmen drove a pick or a wedge into plaintiffs' cable, causing it to fuse. On examination, plaintiffs found the cable stripped for the space of about 4 ft. Defendants had not given notice to open the ground and did not take the trouble to inspect plaintiffs' map of mains.

For the defence it was contended that there was no negligence, and that the main was so near to the concrete as to expose it to danger.

His Lordship found for plaintiffs, and gave judgment for them for the amount claimed, with costs.

Commercial Topics.

The Roumanian Machinery Market.

In a report by Mr. A. A. Adams, H.M. Commercial Secretary at Bucharest, figures are given of the machinery imported into Roumania during 1913. Germany exported steam, petrol and gas engines, dynamos and motors, telegraph and telephone apparatus, electric cables and wires, bells, &c., of the total value of 32,245,000 lei; the United States exports came to 10,226,000, these of Austria-Hungary to 7,566,000, but Great Britain's share was only 3,061,000 lei. It is pointed out that a large proportion of Roumanian implements have become worn out as a consequence of the war, while much of the plant was destroyed during the enemy occupation. Consequently there is a great demand for new machinery. The petroleum, timber and milling industries, the railroads, telephones and telegraphs, and the factories of Old Roumania must be reorganised renewed and reconstructed. To these great requirements must be added those of the new Roumania. It is pointed out that at the moment it is difficult to open up a new market in Roumania, in view of the artificial rate of exchange. It is possible, however, that some special arrangement could be effected (*e.g.*, payment to be made in oil) if British firms desire to be early in the field. It should be remembered that there are plentiful supplies of oil and of undeveloped water-power, and that oil engines and turbines are likely to be extensively used in the generation of electricity.

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Municipal Wiring and Sale of Fittings.

We are threatened with a recrudescence of the dispute between wiring contractors and municipal electric supply undertakings as to whether the latter should have powers to undertake the work of wiring consumers. Though many local authorities, including the whole of the London Borough Councils, have authority to do wiring and fitting, very few of them have exercised their powers, preferring to let local contractors tender for the work. In some cases there is a statutory obligation upon supply undertakings to carry out the wiring through wiring contractors, and the latter have recently endeavoured to get Cardiff Corporation to substitute a similar clause in their Bill for clause 62, which gives the right (inter alia) to sell electrical apparatus, undertake wiring, &c. This the Corporation refused to do, and the matter will come before the Select Committee which will consider the Bill.

It must be remembered that sec. 23 of the Electricity (Supply) Act of 1919 enables a joint electricity authority or a local authority "to provide, let for hire, and in respect thereof may connect, repair, maintain and remove (but shall not unless expressly authorised to do so), manufacture or sell electric lines, fittings, &c." In our view this is an unreasonable restriction upon a commercial undertaking for the hirers of motors and apparatus frequently wish to purchase after an experiment in hiring, and we think local authorities might very well be given the right to sell fittings let on hire. Private gas companies are able to carry out everything in supplying gas, and Cardiff Corporation think it is time they had similar powers. We look upon electricity supply as a commercial undertaking, and all who are entrusted with the business of supply should have full powers to develop it on modern lines. For instance, the heating and cooking load can be greatly expanded by the hire of apparatus, and experience shows that consumers frequently want to purchase articles which they have had on hire, and any restriction upon this desire should be removed without delay.

In this connection it is interesting to note that the London County Council has recently sanctioned a loan of £1,000 for "assisted wiring" in Bermondsey, under a section of the London County Council (General Powers) Act of 1906. Bermondsey proposes to establish a scheme of installations upon (i.) cash purchase, and (ii.) hire purchase. Shoreditch Borough Council recently authorised the preparation of a somewhat similar scheme in consequence of the high cost of wiring.

* * * *

Relief of Rates by Municipal Trading.

There appears to be a healthy reaction in municipal circles against the principle of voting sums in relief of rates from the annual surplus of municipal trading departments. We have often urged that the profits of electric supply and tramways departments should be devoted to a reduction in the service charges, to improvements and extensions of plant and rolling stock, &c., and we are pleased to notice that the Trading Departments Special Committee of Manchester Corporation seem to have come to a similar conclusion, for they report that they "cannot recommend a continuation of the present principle upon which the trading departments make contributions towards the relief of the rates, but recommend that the amount to be carried to the credit of the city rate should be the surplus remaining at the close of the year, after payment of all expenses, including renewals and reserves, or so much of such surplus as is not required to carry on the several undertakings. The charges made for gas, electricity, and tram fares should be kept down to the lowest level consistent with an ample protection against loss, after an adequate provision for renewals and reserves."

Under the existing system the Manchester electricity department pays toward the relief of rates 1 per cent. on a capital expenditure of £3,165,000, the gas department 1 per cent. on £3,099,000, and the tramways 5 per cent. on £2,237,000. The outstanding debt in each department is considerably less, and if the amounts paid to the rates had been levied on that basis probably there would not have been such opposition from the trading departments as there is. We understand that the present recommendation of the special committee has the unanimous support of the Electricity and Tramways Committees. The recommendation will be considered at a special meeting of the Council.

Electricity Supply.

Derby Corporation has applied for sanction to borrow £120,000 for extensions of the electricity undertaking.

Wigan Electricity Committee has placed orders for laying electric supply cables to two mills at a cost of £22,956.

Spenborough Urban Council has applied for sanction to a loan of £5,500 for the erection of a sub-station in the Westgate district.

Lancaster Corporation has applied for sanction to increase the authorised maximum charge for electricity from 8d. to 9d. per unit.

Owing to the flooding of the River Cherwell the supply of electricity at Banbury has been cut off, and several factories have been rendered idle

Blackburn Council has decided to install oil firing auxiliary plant at the Jubilee-street electricity works, together with new transforming plant.

Cardiff Finance Committee has approved the Electricity and Tramways Committee's scheme for extensions of plant, cables, &c., at a cost of £140,325, to meet the estimated load of 1921.

Bristol Corporation, having made certain amendments in the electric supply clauses of their Bill, the Bath Electric Lighting Committee advise the Council to withdraw their opposition.

The General Purposes Committee of Accrington Corporation propose to increase the salary of the electrical engineer (Mr. Clegg) by £150 a year with a further increase of £50 in April next.

Messrs. Adam Paterson & Sons, Ltd., West Mill, Haddington, have decided to introduce Electric Power into their Tweed Mills, which are being extended. Suction gas plant is employed by the firm in generating electricity.

Owing to the increasing demands on Rochdale Corporation Electricity Committee for power supplies, the committee is trying to arrange for a further bulk supply of current from the Lancashire Electric Power Company.

Mr. F. H. Rudd, who was one of the selected candidates for the vacancy for an electrical engineer at Peterborough, has withdrawn his application, and the Rochdale Electricity Committee recommend a substantial increase in his salary.

Dewsbury Corporation has increased the charges for electric current to lighting consumers from 40 per cent. to 50 per cent. over pre-war rates; to ratable value consumers from 50 per cent. to 75 per cent.; to power and heating consumers, from 75 per cent. to 100 per cent.

Mr. H. A. Neville, M.I.E.E., borough electrical engineer of Wakefield, has been appointed electrical engineer and manager of the Peterborough Corporation electricity department, at a salary of £700, rising by annual increments of £50 to £1,000 per annum.

It has been decided by Paisley Corporation to carry out extensions at the electricity works at Blackhall, and also to erect a sub-station at West Croft. The extension at Blackhall is to provide accommodation for extra high-tension switch gear to supply current to the north end of the town.

In a recent report to Burnley Corporation by Mr. E. M. Lacey, M.Inst.C.E., dealt with extensions of the electricity undertaking, and the proposed linking up of Burnley with neighbouring undertakings. It has been decided to constitute a joint authority for an area from the Coast, through East Lancs to Colne.

Owing to recent breakdowns of two generating sets at Bolton Electricity Works several mills, dependent on electric power, have had to close down, but the electrical engineer (Mr. W. J. Wood) is endeavouring to distribute the available supply equitably, and the tramway service and private lighting have been restricted.

In connection with the recent decision to restore the pre-war lighting in Sunderland a start is to be made with the improvement of the supply mains at a cost of £16,000. The demand for electricity in the shipyards on the Wear is increasing rapidly, but it is hoped to be able to meet these demands very shortly.

The Clyde Valley Electrical Power Company is carrying out important extensions of plant at the Yoker power station, where a 25,000 h.p. set has recently been installed. Two similar sets are to be provided in order to cope with the increasing demand for electrical energy in the company's area.

As there is no possibility of a bulk supply, and the question of utilising the water power of the River Eden is not feasible at present, the Electricity Commissioners have expressed approval of the proposal of Carlisle Corporation to erect (at a cost of £100,000) a new generating station for the purpose of supplementing the existing station, at which a rotary converter is to be installed at a cost of £7,000.

Newcastle-upon-Tyne Corporation has been notified by the Newcastle Electric Supply Company that it proposes to change its system to some of the large consumers in the city from the d.c. to the a.c. at 40 periods per second in order to be able to meet the large demands for power. New mains will be laid, and these will relieve the existing direct-current mains which will then be able to deal more satisfactorily with the smaller consumers.

Modifications have been made in the scheme for the Supply of Electricity in the East Midlands. Originally it was proposed to erect a super-power station at Nottingham to supply the whole of the area, but it is now suggested that separate stations should be constructed at Nottingham, Derby and Leicester, each one serving, approximately, the respective counties. The area of supply will not, however, follow exact county definitions, the nearness of the smaller towns and villages to the three central places being the determining factor. It is estimated that 13 millions will be required for the Nottingham scheme.

The Electric Drive in cotton mills appears to be making rapid progress in Lancashire at present. The first sod was cut on the 7th inst. of a factory in Bolton which will provide the largest block of cotton spinning mills in the world. All will be electrically driven and energy will be supplied by the Corporation Electricity Works. The full scheme will provide accommodation for 1,000,000 spindles. Messrs. Knowles, Ltd., of Egyptian Mills, are also erecting a new spinning mill which will be electrically driven, and Messrs. Hesketh, of Astley Bridge Mill, and Messrs. Thomasson & Sons, of Mill Hill Mills, are also making similar extensions.

Owing to a sudden strike of the employees at the Southampton Corporation electricity works, on Tuesday evening, the supply of electric power was cut off and many factories had to close down. The supply for hospitals and street lighting is being maintained owing to the efforts of the engineer (Mr. H. S. Ellis) and his assistants who, with the aid of a small voluntary staff, have kept the station running. About 180 men came out on the instructions of the Electrical Trades Union, owing to a dispute between the Union and the Electrical Power Engineers' Association. The superintendent of the station was a member of the Electrical Trades Union, but he resigned and joined the E.P.E.A.

For some time the Hove Lighting Committee has been considering the question of extensions of plant or of obtaining a bulk supply from Brighton, and the whole question has been referred to the Electricity Commissioners. Hove thinks it can generate more cheaply than by taking a bulk supply. Brighton Corporation offers a three-phase supply at 7,500-8,000 volts on certain conditions, including a guarantee of not less than 300 k.v.a. per annum for 20 years. Brighton would lay two e.h.t. feeders to the Hove station and Hove would provide, maintain and operate the necessary transformers, rotary converters, &c. The charge for energy would be £8 per kilovolt-ampere of maximum demand plus 1·5d. per unit metered with coal at 40s. per ton, subject to an increase or decrease of 0·03d. per unit per shilling a ton as the price of coal varied above or below this figure.

In a report on the introduction of electricity supply in Crieff, Mr. J. E. MacEwan, of Glasgow, recommends that a canvass of the area be made, that the Electricity Commission be asked for the required permission to appoint a Local Electricity Authority, and that a committee and engineer be appointed to prepare a detailed scheme. Mr. MacEwan estimates that a water-power scheme would cost £55,764, while semi-Diesel plant would cost £14,664 and suction gas plant £15,344. Steam-driven plant is ruled out, but the best method would be to take a bulk supply from a power company if it were available. The ultimate possibility of utilising the water power of the River Turrett should not be lost sight of, but in any event distribution should be by means of overhead cables. While a scheme might not pay its way for the first three years, it must be remembered that there is a present and ever-growing demand for electricity both for business and for domestic use, and the advantages accruing from electricity in a health resort should also be borne in mind.

In order to give an impetus to the proposal to introduce electricity supply it is suggested that a local electrical exhibition should be held for the purpose of demonstrating the possibilities of electricity for domestic and industrial purposes. A Committee has been appointed, consisting of some members of the Council and several prominent ratepayers, to carry out the suggestion.

Catalogues, Price Lists, &c.

In a leaflet issued by the "Z" Electric Lamp Mfg. Company, details are given of the "Z" vacuum cleaner.

The monthly stock list of the Stanton Ironworks Company gives dimensions and prices of the c.i. pipes available for delivery.

The Enterprise Manufacturing Company, Gun-street electrical works, Bishopsgate, E. 1, has issued a card giving prices and particulars of the "Smoovit" electric iron.

We have received a copy of the booklet issued by the National Boiler & General Insurance Company, entitled "Notes on Gas and Oil Engine Accidents." The booklet consists of practical information for gas engine users, based on the experience of the company, and describes the most frequently occurring failures and gives hints for their prevention.

A leaflet issued by the Credenda Conduits Company, Ltd., Aston, Birmingham, contains some particulars of the new "Creda" kettle, which the company has just produced. The kettle is of handsome design, highly finished in nickel plate and suitable for afternoon tea. The loading is 600 watts, it holds 2½ pints and will boil from cold in 14 minutes.

In a neatly printed booklet of 16 pages, entitled "The Essential Factor," the Sun Electrical Company, Ltd., give brief particulars of the leading lines that are either exclusively manufactured by them or of which they hold patents and registered designs. After a historical introduction, reference is made to the "Sunco" electric fires, "Xcel" heating appliances, Sunlite reflectors and lanterns for half-watt lamps, "Sunco" electric signs and flashers, the Kalkos system of wiring, fuse-boards, &c. Most of these lines have been manufactured by the company for a lengthy period, and copies of the booklet, which is intended as an introduction to their general catalogue, can be obtained from 57-59, Neal-street, Long Acre, London, W.C.2. The booklet is also printed in French and Spanish.

Electric Traction.

South Shieles Corporation has authorised an increase of 50 per cent. in the tramway fares.

An electrically-driven power wagon is to be used by Sunderland Corporation for overhead tramway maintenance in place of the existing horse tower wagon.

Owing to the recent increase in the wages of the employees, Edinburgh Tramways Committee has asked the tramways manager (Mr. R. S. Pilcher) to prepare a revised scale of fares.

Colne Tramways Committee recommend the Council to purchase bogie cars. There is considerable opposition on account of the curves on the track and it is urged that bogie cars would cause delay.

Blackpool Corporation are taking a temporary supply of electric power from Fleetwood for the newly acquired Blackpool-Fleetwood tramway north of Rossall. Fleetwood Council will be paid 10 per cent. on the cost of generation.

At a special meeting of the London County Council on Tuesday it was decided to make an issue of £7,000,000 London County 5¾ per cent. bonds. Out of the proceeds of the issue £260,000 will be required for work under Acts relating to the tramways but the greater part is for housing.

The Urban Councils of St. Annes and Lytham have come to an agreement regarding the purchase of the Blackpool, Lytham and St. Annes Tramway Company. St. Annes will take over the line and Lytham will receive a percentage of profit made on the section in their area.

Recently the Glasgow Corporation tramway employees asked for an advance of 10s. per week in the wages of all employees and the Corporation is now recommended to grant the following increases:—7s. per week to men, 4s. 6d. to women, and 3s. 6d. to youths under 18 years of age. The increases are to be retrospective as from March 14 and will involve an additional annual expenditure of practically £100,000.

The Minister of Transport has extended by one year the times limited for various works in connection with the Edgware & Hampstead Railway.

The Minister has also extended for a further period of one year from Feb. 15, 1920, the period limited by the Western Valleys (Mon.) Railless Traction Act, 1913, for the completion of trolley vehicle equipment and road widening, and the period limited by the Western Valleys (Mon.) Railless Electric Traction (Extension) Order, 1914, for completion of trolley vehicle equipment have been extended for one year from July 8, 1920.

Newcastle-upon-Tyne Corporation has received authority to construct a light electric railway through Gosforth Park, and this will enable the Tramways Committee to link up the North-road route with the Benton cars, and so make a circular route. Owing to the increased cost of maintaining the tramway service, the City Council has revised the fares in order to bring in an additional £60,000 or £70,000 per annum.

The accounts of the Liverpool tramways dept. for 1919 show gross capital expenditure £2,129,705 (increase £61,310), of which £1,042,140 has been redeemed, whilst the sinking funds amounted to £642,716, and the reserve, renewal and depreciation account to £284,350. The year's revenue was £1,207,228 (compared with £989,504 in the previous year), and operating costs, including rent of leased lines, were £1,029,443 (£716,479), leaving gross profit £177,785 (£273,025). Interest and sinking fund required £102,300 (£103,703), and net profit was £75,484 (£169,322). Operating costs per car-mile were 18·739d. (14·082d.), and revenue was 21·46d. (18·91d.). Passengers carried were 208,251,496 (increase 13,168,887), and car-miles run 13,184,277.

The Ministry of Transport, which has been considering the contribution to be paid by tramway and motor omnibus authorities for the upkeep of roads over which they run services outside their own district, has drawn up model clauses which they suggest should be inserted in future Bills. The principal provision is that "the local authority shall pay to the road authority an annual contribution in respect of the use of the road at a sum to be agreed between the parties or, failing agreement, settled by the Ministry of Transport."; and that the authority running the motor omnibuses shall, in proper cases, pay such a sum for the reconstruction of the roads so as to fit them for motor omnibus traffic as may be agreed, or, failing agreement, may be settled by the Ministry." Sir Henry Maybury stated in a recent case that he thinks the charge for the use of the road should not exceed 1½d. per bus mile, and that for the reconstruction of the road a sum not exceeding £750 per mile should be paid.

The suggested rates are much above the existing statutory charges, but probably they are not above what modern conditions require.

Business Items, &c.

Messrs. Charles P. Sparks & Partners have taken into partnership Capt. Algernon Charles Sparks, M.C.

Chas. and Edwin Chas. Gates, electrical engineers and advertising sign manufacturers, 56, London-street, Norwich, have dissolved partnership. Debts by Mr. Chas. Gates, who continues as E. & C. Gates.

The Electric Controller & Manufacturing Company, Cleveland, O., notify an increase of prices, owing to the increasing cost of material and of labour. The increase will take effect from May 1.

Messrs. C. A. Vandervell & Company, Ltd., of Acton, have been granted the warrant of appointment as manufacturers of electrical equipment for motor-cars to His Majesty the King, with authority to use the Royal Arms.

Imperial and Foreign Notes.

Newcastle (N.S.W.) Council has applied to the Commonwealth Government for sanction to a loan of £30,000 for electric supply purposes.

Launceston (Tas.) City Council proposes to put down a further 1,000 H.P. of electric generating plant at the South Esk station, near Launceston.

Mr. R. W. Canning, lecturer on electrical engineering at the Perth (W. Australia) Technical School, has been appointed lecturer in mathematics and electrical engineering at Hobart University.

The Hurstville, Kagarah, Rockdale and Sutherland (N.S.W.) Shire Councils are also considering a scheme for obtaining a bulk supply of electrical energy from the Railway Commissioners.

West Maitland (N.S.W.) Council has decided to accept a proposal by the Railway Commissioners to supply electricity in bulk for use in the district. The capital expenditure involved is estimated at £15,000.

Messrs. A. C. F. Webb & Burgess, consulting engineers, Sydney, have been appointed by the Municipality of Bathurst (N.S.W.) to report on the subject of electricity supply in the city.

Healesville (Victoria) Shire Council has adopted an electric lighting scheme, estimated to cost £7,500. Two alternators (of 50 kw. and 10 kw.) will be driven by suction gas engines.

A bill providing for the erection of hydro-electric works at Barrinjuck and on the Nymboida River (N.S.W.), at a cost of about 1 million pounds, has passed the committee stage in the N.S.W. Legislative Council.

In view of the departure of Mr. J. H. Butters, chief engineer and general manager of the Tasmanian hydro-electric dept., for England and America, Mr. F. M. Wishall has been appointed deputy chief engineer and general manager.

The ratepayers of Wollongong (N.S.W.) have resolved to accept the offer of the Public Works Department for the supply of three-phase electric current for five years, with option of renewal for five more. The charge will be under 2d per unit.

Standard-Waygood-Hercules, Ltd., of Sydney (N.S.W.), have acquired a large interest in G. Weymouth Pty. (Ltd.), electrical engineers, of Richmond, Victoria, and the name of the company is to be changed to the English Electrical Company of Australia, Ltd. Mr. G. Weymouth has been appointed managing director.

The French Ministry of Industrial Reconstruction has received a proposal from M. L. New to substitute the importation of electric energy from England to France for the importation of coal. A large generating station would be erected near Dover and energy would be transmitted by submarine cables to the Nord.

The electric supply works in Guatemala, which were erected by Siemens & Halske about 25 years ago, have been acquired by an American subject. More than 90 per cent. of the shares of the local company (the Empresa Electrica de Guatemala) were held by the Deutsche Bank of Berlin, but the whole of the plant, machinery and goodwill of the company were taken over by the Guatemala Alien Custody Association and declared forfeited to the Guatemala Government and nationalised. Recently the property was handed over to Mr. Henry W. Catlin, of New York, for a term of 10 years, at a cash rental of £8,000 per annum, together with the option of extending the lease for an additional like period. The Government concession under which the old company operated has been extended, with the provision that a further extension will be granted, and the lessee becomes the preferred tenderer in any future sale of the property. The plant is hydro-electric, with a present capacity of 2,000 kw. The three-phase current is transmitted at 4,000 volts from the power station at Palin, about 28 miles from Guatemala City, and is reduced at the local station to 1,000 volts for primary distribution over the city, the house service being at 120 volts. Some 16,000 incandescent and 280 street arc lamps, with 2,000 H.P. in motors are supplied. Mr. Catlin's company also acquires the right to use additional water power and an uncompleted station at San Luis, about six miles from Palin, which will give an additional 3,000 kw. There is a considerable demand for additional light and power service in the newly-constructed city. There is also a good demand for electric signs, &c. The value of the present electrical plant is $1,000,000 (£200,000), and the cost of completing the new auxiliary station $300,000 (£60,000).

Educational.

The University College, Reading, is petitioning the Crown for the grant of a charter conferring upon it the status and powers of an independent University under the title of the University of Reading.

We have received from the Old Students' Association of Finsbury Technical College a copy of the Magazine for April. This is the first issue of the Magazine since the war. We understand that a move is being made to re-organise the Association to make it of real value to students resident in the provinces, as well as in London. The proposed new rules of the Society appear in the Magazine, and a general meeting to deal with them and to discuss the future conduct of the Association will be held at the College, Leonard St., Finsbury, on May 4, at 6.15 p.m., when it is hoped all old students will be present. The annual conversazione will be held at the College on Friday evening, April 30, tickets for which will be obtained from the Conversazione Secretary at the College. Further information regarding the Association may be obtained from the Honorary Secretary at the College.

Miscellaneous.

The late Mr. Charles Edward Groves left £33,082, with net personalty of £32,857. The testator created a trust for his five sisters for life, and on the death of the survivor £10,000 goes to the Royal Institution for the "Groves Endowment Fund" for the promotion of scientific research.

In reply to a question, Mr. Pike Pease stated in the House of Commons on Monday that the increase during 1919 in the number of telephones in the United States of America, including the Bell system and independent companies not connected with the Bell system, was 664,422, or 5·5 per cent., and in the United Kingdom (Post Office system) 59,550, or 7·1 per cent.

The staff of the Lea Recorder Company, Ltd., held what is hoped will be their first annual dance and social at Smallman's Cafe, Manchester, on the 10th inst. The directors and other guests were invited and a thoroughly enjoyable evening was spent. The programme included a dance and whist drive, the prizes being presented by Mrs. J. E. Lea.

The Old-street Police Court Magistrate (Mr. Clarke Hall) has sentenced Edmund Geo. Thorn-Davis, electrical engineer, to four months' imprisonment for obtaining an Electrical Motor (valued at £66) by False Pretences from Messrs. Cordingley & Mills. Defendant gave in payment a cheque which was dishonoured. On the day he received the motor he sold it to another firm for £68 10s. It was stated that there were other dishonoured cheques, the total sum represented being over £1,000.

On the 8th inst. Mr. Chris Wilson, the well-known and genial director controlling the Osram-G. E. C. lamp works, was installed in the chair as worshipful master of the Hammersmith Masonic Lodge. The ceremony was ably carried out by Mr. G. G. Bell, installing master, who is the Borough Electrical Engineer, and at the banquet which followed, the new master was supported by approximately 170 brethren and visitors, including Grand Officers Sir Newton Moore (P.P.G.M. Western Australia), P. P. Kipping, P. Asst. G. S. Wks. R. C. Collins, &c. The toasts were remarkable for brevity, and the replies were in the same strain, a fact which enabled due justice to be done to the excellent musical programme. All had a most happy time and the Hammersmith Lodge looks as if it were in for another busy year.

A special sitting of the Industrial Court was held on Wednesday to consider questions of interpretation on the last award applying to the engineering and foundry trades. The Court awarded an advance in time or day rates of 6s. per week, 3s. from the end of March and a further 3s. from the end of May.

Exception has been taken to the decision of the Court that, while the Increase of the Cost of Living did not alone justify a further advance, the remuneration of the various classes of workpeople should "in ordinary circumstances depend on the value of the work done, and this depends on the state of the market and the demand for the products of the workshop." The award further stated, "The present position in the engineering industry is abnormal owing to the great demand for engineering products." The employers urge that the Court has given an award on points that were not included in the application, and on a basis on which no evidence was submitted. This particularly applies to the relation of wages to the value of work done, and to the state of the market and the demand for products of the workshops. Objection is also taken to the clause in which it is stated that the Court "have given consideration to the wages movements in other industries in comparison with those which have taken place in the engineering and allied trades, and to the desirability of securing and maintaining for a reasonable period a measure of stability in the engineering industry."

Personal and Appointments.

Mr. A. J. Waring, of Walsall, has been appointed mains engineer, and Mr. F. C. Honeywill, of the Cleveland and Durham Power Company, charge engineer at Torquay.

On the 5th inst., at St. Nicholas Collegiate Church, Galway, Mr. Frank J. Moffett, B.A., M.I.E.E., of Birmingham, was married to Lucy Evelyn second daughter of Mr. and Mrs. R. B. Smith, of Galway.

Mr. J. M. Keenan, deputy-engineer and manager of Torquay Corporation electricity works, has been presented with a silver tea service by the staff and employees on leaving to take up the position of engineer and manager of the Isle of Thanet Electric Tramways & Lighting Company.

We regret that we omitted from the list of Civilian War Honours in our last issue the name of Mr. Phillip Vassar Hunter, M.I.E.E., joint manager of Callender's Cable & Construction Company, Ltd., who has been awarded the C.B.E. During the war Mr. Hunter was representative of the Director of Experiments and Research in the Admiralty Anti-Submarine Division.

A presentation of a handsome coffee set has been made to Mr. W. A. Gillott upon the occasion of his leaving the Newcastle-upon-Tyne Electric Supply Company, after 14 years' service, to take up the position of sales engineer to the Jackson Electric Stove Company, Ltd., who have recently acquired premises for offices and showrooms at 143, Sloane-street, London, S.W. 1. For many years Mr. Gillott has concentrated his energies upon the development of the electric cooking and heating load, which now amounts to over 10,000 kw. on the north-east coast network, and his experience will be of great assistance in designing new apparatus. We understand, however, that one of his immediate tasks is to establish and organise a selling department, and he is now compiling data for the publication of catalogues, &c.

Institution Notes.

At the last meeting of the Wireless Society of London, it was unanimously decided to admit ladies to the Membership and Associate Membership of the Society. Captain Donnisthorp showed an invention consisting of a "pocket-book" receiving apparatus which was recently patented, while Mr. Powell-Rees exhibited the "Polaris" receivers which are also compact pieces of apparatus.

At the invitation of the committee on the Western Centre, the summer meeting of the Institution of Electrical Engineers will be held at Cardiff from July 13-16th inclusive. Arrangements have already been made for a number of public functions, and excursions in the neighbourhood and visits will be made both to Bristol and Swansea. A supplementary excursion to Hereford on Monday, July 12, has also been arranged.

The first general meeting of the members of the Melbourne division of the Institution of Engineers of Australia was held recently. The following officers were elected: *Chairman:* Mr. M. E. Kernot; *Vice-Chairman:* Lt.-Gen. Sir John Monash and Mr. A. C. MacKenzie; *Committee:* Prof. Payne, Messrs. B. A. Smith, W. W. Robertson, G. G. Jobbins, W. J. Newbigin and F. Fairley; *Hon. Secretary:* Mr. C. Newton; *Hon. Treasurer:* Mr. A. Maling.

The International Electrotechnical Commission have issued Volume I. of the I.E.C. Rules for Electrical Machinery. These Rules apply to rotating machines of which the terminal pressure does not exceed 5,000 volts, or of which the rated output does not exceed 750 k.v.a., or of which the stator cores do not exceed 50 cm. in length axially, and to all transformers which are not water cooled. These rules were criticised at a recent meeting in Birmingham, and an account of the discussions was given in our last issue.

At a recent meeting of old students it was decided to form an Old Students' Section of the King's College Engineering Society as a branch of the King's College Old Students' Association. The objects are to keep old students in touch with one another and to promote their interests. Mr. C. H. Wordingham, C.B.E., has been elected president, and Prof. Ernest Wilson and Brig.-Gen. M. Mowat vice-presidents. An inaugural luncheon will be held at the Holborn Restaurant at 12.45 p.m., May 1, at which the Committee's plans will be fully explained, and it is hoped that all former students of the engineering faculty will attend. Further particulars can be obtained from Mr. A. N. Gardiner, 2, The College, Epsom.

The position of students whose studies were interrupted by the war has been sympathetically considered by the Council of the Institute of Metals. It has been decided to recommend for ballot as student members of the Institute candidates for election who, whilst being students of metallurgy, have passed the age limit of 25 years for admission to student membership. Students so elected may remain student members up to June 30, 1923, so long as they continue to be students of a recognised school of metallurgy. Though in operation for only a few weeks past, the arrangement has resulted in student membership applications being received to a greater number than was the case in the whole of 1919. By a further concession, members and students elected at the forthcoming ballot on May 31, will have the privilege of membership for thirteen instead of twelve months, but will receive an extra copy of the "Journal of the Institute of Metals."

At the last meeting of the Faraday Society the President, Sir Robert Hadfield, Bart., F.R.S., made public the important part the Society had taken in 1916 and 1917 in the movement which led to the formation of the Nitrogen Products Committee, the Report of which was recently published. The occasion of the announcement was the receipt of a letter of thanks from Sir Graham Greene, Secretary of the Ministry of Munitions, acknowledging the help rendered by the Society and many of its members. The letter states that arrangements are now on the point of being concluded whereby the synthetic ammonia factory which had been partially erected is to be transformed into a commercial project on a very large scale, and many other fixation schemes are under consideration throughout the Empire. It concludes that the Faraday Society will doubtless consider the objects it had in view, in bringing the Nitrogen Problem before the Ministry, have been in a great measure achieved.

The subject of the insurance of Diesel engines against breakdown was considered at the March meeting of the Diesel Engine Users' Association. Some years back the Association adopted a standard form of insurance policy at Lloyds, and as a result of experience gained in the working of this scheme of insurance, the conditions of the policy have been amended in certain respects. The new form of policy eliminates from its scope claims for cracks or partial fractures which do not in themselves result in an actual "breakdown." This will have the advantage of making such costs chargeable to the ordinary annual maintenance account. A Paper on the subject of "Obturators" was read by Mr. W. Fennell. In pointing to the advantages of using obturators in place of piston rings in petrol engines for aeroplane work the author said the actual power wasted in piston ring friction was in many cases as much as 75 per cent. of the total mechanical loss in an engine. The obturator is a sort of "cup leather" made of thin metal, originally brass, but now specially selected phosphor bronze. It is usually placed very near the top of the piston, yet it does not burn owing to its flexibility which enables it to be kept in perfect contact with the cylinder where it is well cooled. By using an obturator instead of a piston ring the author considered that Diesel engine design might be considerably modified, resulting in reduced height and weight and the introduction of cross-head engines.

Tenders Invited and Accepted.

Dunedin (N.Z.) Council require tenders by April 26 for electric car bodies, car trucks and equipment. Specifications from the Town Clerk.

The Chester Housing Committee require tenders for wiring 54 houses on the Buddicon estate, Saltney. Specification, &c., from the Town Clerk.

Pembroke (co. Dublin) Council require tenders for a 500 kw. steam generator set. Specification, &c., can be obtained at the Town Hall, Ballsbridge, Pembroke.

Kilmarnock Corporation invite tenders for the electric wiring and fitting of 156 houses in connection with their Holehouse-road housing scheme. Schedules, &c., from the Burgh Surveyor.

Dublin Electricity Supply Council require tenders by noon, April 24, for the supply of seven truck type switch cubicles for use on a 3-phase, 50 period 5,000 volt system. Specifications from City Electrical Engineer.

Wrexham Corporation require tenders for water-tube boiler and superheater, &c., overhead bunker, ash elevator and hopper, centrifugal pump, e.h.t. cables, &c. Specifications from the Electrical Engineer.

The "Gaceta de Madrid" of March 14 states that tenders will be opened on May 18 at the Spanish Ministry of Development for a concession for the construction and working for 60 years of an electric tramway from Corunna to Sada.

Neath Corporation require tenders for the reconstruction of tramways, including track, overhead equipment, car depot, sub-station equipment, cars, &c. Conditions, &c., from the Borough Engineer, Neath, or Mr. A. Ellis, 9, Park-place, Cardiff.

Canterbury Corporation invite tenders for one 1,000 kw. three-phase turbo-alternator and surface condenser two rotary converters and a superheater. Specifications from Messrs. May & Hawes, 36, Victoria-street, S.W.1, and tenders to Town Clerk by 4 p.m., April 19.

Cardiff Corporation invite tenders for the supply and erection of a 5,000 kw. turbo-alternator and surface condensing plant. Specifications and forms of tender from the Electrical Engineer, The Hayes, Cardiff, and tenders to the Town Clerk by April 29.

Tenders are invited up to May 5 for supply and delivery to the Postmaster-General's Department, State of Western Australia of insulators, bolts, brackets, &c. Specifications from the Commonwealth Offices, Room 406, Australia House, Strand, London, W.C. 2.

Sunderland Corporation invite tenders for two water-tube boilers, with integral superheaters, mechanical stokers, vertical c.i. tube economisers, one 1,000 kw. rotary converter, &c. Specifications from Mr. A. S. Blackman, and tenders to Town Clerk by April 28.

The Uruguayan Legation, 3, Elvaston-place, London, S.W. 7, announces that the Department of Posts, Telegraphs and Telephones of Uruguay invites tenders (by Aug. 7) for the construction of a national telephone system for the Department of Montevideo.

The Agent-General for Western Australia invites tenders for one 7,500 kw. turbo-alternator and condensing plant for the Perth power station. Specifications from Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1, and tenders to the Agent-General, Savoy House, Strand, London, W.C.2, by noon May 14.

W. T. Henley's Telegraph Works Company have secured a contract from Madras Corporation, through the Crompton Engineering Company (Madras), Ltd., for 20 miles of underground cable.

Battersea (London) Council is recommended to accept the tender of the Fraser & Chalmers Engineering Company for a turbo-alternator and Mirrlees condenser, £35,335.

Hull Corporation has accepted the tenders of Richardsons, Westgarth & Company, for condensing plant at £17,784; and of the Stirling Boiler Company for two boilers at £15,470.

Bedford Electricity Committee recommend the Council to accept the following tenders: Siemens Bros. & Company, e.h.t. cables, £4,707; British Electric Transformer Company, two 350 k.v.a. transformers, £990; and Ferguson Pailin, Ltd., e.h.t. switchgear, £794 15s.

York Corporation has accepted the tender of the English Electric Manufacturing Company for plant and work in connection with the hydro-electric station at Linton Lock at £53,057; that of the Maschinenfabrik Oerlikon (Ltd.) for turbo-alternator and condenser for the existing station at £27,092; and that of Callender's Cable & Construction Company for cables at £9,445.

Telegraph and Telephone Notes.

The Postmaster-General has notified the Corporation that he cannot install an Automatic Telephone Exchange in Bolton, and he thinks that central battery manual plant, which will be employed, will provide a service as efficient as would be obtained from the automatic system.

In a circular issued to the shareholders of the Northern Exploration Company, Ltd., it is stated that the two Wireless Stations which were erected last year have been of the greatest value and importance in keeping the London office in close touch with the management and work on the properties in Spitzbergen.

Messages of greeting, demonstrating the possibility of long distance wireless telephony, were transmitted on the 9th inst. to the principal Italian newspapers by Italian journalists resident in London. The Marconi Company's long distance apparatus at Chelmsford was employed and the messages were received at Centocelle, about 4 miles from Rome. Immediately after the demonstration a reply was received by wireless telegraphy from the representatives of the Italian papers.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications

138.708 Hope-Jones & Synchronome Co. Automatic indicator of failing electric current (17 2,19.)
138.721 Adams. Automatic electric control apparatus. (27 2 19.)
138.723 Siemens Bros. & Co. & Grinsted. Production of tone currents for telephone circuits (27 2 19.)
138.728 Benjamin Electric, Ltd., & Campbell. Electric adaptors for lighting and other purposes (5 3 19.)
138.744 Rei Electric power steering gear for ships or other vessels. (19 3 19.)
138.745 Western Electric Co. Methods of and apparatus for producing vacua. (2 /3 19.)

A method of producing a vacuum by withdrawing the gas from the vessel to be evacuated into a stream of vapour, by removing from the vapour stream, before it encounters the gas to be withdrawn, substantially all vapour molecules not moving in paths substantially parallel to the direction of the flow. This is accomplished by cooling the surface of the stream of vapour in advance of the point at which it encounters the gas to be withdrawn.

138.753 Drysdale & Co., Drysdale & Young. Electrically-driven rotary pumps. (28 3 19.)
138.756 Schattner. Electrical time switches. (1 4 19.)
138.773 Ivey & Salisbury. Electric storage battery cells. (22 4 19.)
138.807 Richardson & Palmer. Electrical indicating devices to be used on taxicabs and the like. (3 7 19.)
138.828 Stewart & Penman. Fuse fittings. (24 9 19.)
138.835 Schattner. Electric excess current indicators. (1/4/19, Divided application on 138.756.)
138.957 Nissen. Electric switch for use with burglar alarms. (4 1 19.)
138 966 Automatic Telephone Mfg. Co. & Smith. Arrangement for indicating or utilising vibratory movements of amplitudes insufficient to effect the opening or closing of an electrical circuit or to give a visual indication. (17 1 19.)
138 967 Bolton. Electro-plating. (17 1 19.)
138 968 Sterling Telephone & Electric Co., Bell & Davey. Signalling systems for use in mines and for similar purposes. (2 1 19.)
138.970 Hewlett. Apparatus for electrically testing magnetos and the like. (23 1 19.)
138.980 Kitching. Supporting means for light-diffusing shades on electric lamps. (1 2 19.)
138.987 Cable Accessories Co., Reeves & Crawford. Electric switches. (12 2 19.)
139.000 Automatic Telephone Mfg. Co. & Friendly. Automatic or semi-automatic telephone systems. (20 2 19.)
139,001 London Battery Co. & Clarke. Electric storage batteries. (21 2 19.)
139,003 Automatic Telephone Mfg. Co. & Green. Electrical signallling systems, such as are used in mines. (22 2 19.)
139,004 Automatic Telephone Mfg. Co. & Green. Electrical signalling systems, such as are used in mines. (22 2 19.)
139.032 B.T.-H. Co. (G. E. C.) Protective devices for electric circuits (19 3 19.)
139.038 Sykes Interlocking Signal Co. & Tarrant. Electromotor. (24 3 19.)
139.055 Allott & Dean. Electrical relays or contact-makers for mine signalling apparatus and for other purposes. (5 4 19.)
139 061 Abbott. Electric fuses. (11 4 19.)
139.066 Holt & Brolt. Means for ventilating dynamo-electric machines. (24 4 19.)
139.078 Kuntzmann. Electric welding tongs. (19 5 19.)
139.085 Bower. Covers to electric switches, bell pushes, wall plugs, sockets, and the like. (2 6 19.)
139.087 Rutherford. Electric switches. (4 6 19.)
139.128 Kessler & Hammond. Electric plug coupling. (10 10 19.)
139.135 Joyce & Park Royal Engineering Works. Electric switches. (28 5 19. Divided application on 13,453 19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

November 26.

29.446 Williams. Terminal electrical connections for sparking plugs.
29.448 Cox & Palmer. Filaments for electric glow lamps.
29.453 Brook & Hirst. Switchgear for electric motors.
29.468 Snarman. Induction coils.
29.473 Needham. Electrically-heated flat irons.
29,480 Hewett. Heating, ventilating, &c., apparatus using electricity, gas, &c.
29.481 Andrews & Say. Electric fire and burglar alarm systems.
29.504 Electrolytic Zinc Co. Recovery of zinc by electrolysis. (3/12 18, Australia.)
29.515 Soc. Anondite Color. Electric stoves. (29 11 18, France.)
29,521 Rose. Switches.
29,523 Automatic Telephone Mfg. Co. (Automatic Electric Co.) Automatic switching mechanism for telephone, &c., systems.
29.526 Tate. Separator for storage batteries. (8/3 19. U.S.)
29,527 Stephenson. Dynamo electric machines. (10 10 18. U.S.)
29,528 Stephenson. Dynamo electric machines. (15 5 19. U.S.)
29,531 Monkhouse. Combined motor car bonnet lock and magneto switch.

November 27.

29,547 Barber. Electric condensers.
29.561 Browning. Electrically heated soldering iron.
29,585 Walker. Dynamo electric machinery.
29,611 Metropolitan-Vickers Electrical Co. Geared turbine installations.
29,617 Western Electric Co. Signalling circuits.
29.626 Hardie. Electric and other light fittings.

November 28.

29.672 Suchostamer. Magneto motors.
29.673 Sucnostamer. Dynamo electric machines.
29,683 Zweigborgk. Electric motors.
29.690 Siemens, Grinsted & Petithory. Electric relays.
29.691 McLaren. Electric bell pushes or contact makers.
29.706 Burdon. (Siemens Schuckertwerke). Arc lamps for searchlights, &c.
29.722 Sproates. Reflectors for electric fittings.
29.740 Automatic Telephone Mfg. Co. Automatic or semi-automatic telephone systems. (13/3/20, U.S.)
29,746 Verdini. Electric heating apparatus.

November 29.

29.723 Western Electric Co. Electric discharge apparatus.
29.783 Deakin. Insulating and anchoring device for electric lamp holders, &c.
29.801 Cowper-Coles. Manufacture of metallic plates by electro-deposition.
29,813 Automatic Telephone Mfg. Co. & Flynn. Telephone systems.
29,816 Bray. Electrically-actuated mechanism for producing sliding or rotary motion.
29,820 B. T.-H. Co. (G. E. Co.) Controlling mechanism for electric circuits.
29,826 Barbour & Walton. Electric control gear for dynamo electric machines.
29,836 Drummond. Electric tramway cars.
29.847 Cowper-Coles. Obtaining hard springy copper by electro-deposition.

Companies' Reports, &c.

The directors of Monte Video Telephone Company, Ltd., have declared an interim dividend on the ordinary shares for the half-year ended Jan. 31 last at rate of 6 per cent. per annum, tax free.

The directors of the Indo-European Telegraph Company, Ltd., recommend a final dividend for the year 1919, of £1 2s. 6d. per share, making (with the interim dividend already paid) 7 per cent. for the year, tax free; also a distribution out of equalisation of dividends fund of 15s. per share, making a total distribution of 10 per cent. The dividend and distribution will be payable on May 1.

Tenders are invited from the certificate holders of certificates of the Submarine Cables' Trust to be redeemed out of surplus income, accrued to the 15th inst., at a price not to exceed £120 per certificate. Holders desirous of surrendering their certificates should communicate with the secretary (Mr. Sidney Collett), stating the lowest price they are willing to accept.

The directors of Callender's Cable & Construction Company, Ltd., propose to subdivide the existing 180,000 shares of £5 each into 900,000 of £1 each by subdividing each of the issued 80,000 6½ per cent. cumulative preference shares into five fully-paid 6½ per cent. cumulative preference shares of £1 each, each of the issued 80,000 ordinary shares into five fully-paid ordinary shares of £1 each, and each of the unissued 20,000 ordinary shares into five ordinary shares of £1 each. It is also proposed to increase the capital to £1,300,000 by the creation of 100,000 new shares of £1 each.

The report of the British Electric Transformer Company, Ltd., states that, after paying all manufacturing costs and expenses of administration the net profit for 1919 was £48,039, and with £3,964 from 1918 the total available is £52,002. The Board propose to place £10,000 to reserve and £3,000 to depreciation reserve, to pay the preference dividend of 6 per cent. for the year (£8,407) and also a dividend of 10 per cent. on the ordinary shares (3 per cent. of which was paid as an interim dividend in September) with a bonus of 2½ per cent. (£17,550). After paying £2,522 as extra remuneration to the directors a balance of £10,523 is being carried forward.

The directors of Vickers, Ltd., regret that owing to the immense volume of work executed for Government during war years—much of which had to be undertaken without prices being fixed—there are Government contracts yet remaining unsettled, some reaching back as far even as 1916. It is still, therefore, not possible to present accounts for 1916, or any subsequent year. It is hoped that final accounts up to end of 1919 may be presented before end of the year. The directors, after careful consideration of all circumstances and of the necessity for preserving and increasing the financial strength of the company, have decided, subject to sanction in general meeting, to declare a final dividend for 1919 of 1s. 3d. per share, or 6¼ per cent., making, with interim dividend, a total for the year of 2s. 3d. per share, or 11¼ per cent. The main works of the company and of the associated companies are well filled with orders.

Mr. A. M. Quill, who presided over the annual meeting of the Madras Electric Tramways (1904), Ltd., on Thursday last, stated that £24,118 was expended last year, mainly on new rolling stock, and on extension in Mount-road. Good progress has been made with the permanent way, but labour troubles in this country caused delay in shipment of poles and other materials, and some time would elapse before the extension could be opened for traffic. When the line was completed important extensions of the system would become practicable. Notwithstanding the strike in March and April of last year, their traffic receipts and number of passengers carried showed increases of 9 and 10 per cent. respectively. The employees got further increases in wages and a re-arrangement of the hours of labour. Another strike occurred in January last when further increases and allowances were granted, which would affect the company's net revenue this year. During 1919 various modifications in fares were made to bring them up to the statutory limit, but the increases only partially met the enhanced costs of running.

Presiding over the recent meeting of the Isle of Wight Electric Light & Power Company, Ltd., Mr. F. E. Gripper said the past year's accounts showed a very substantial improvement over the previous year, although there still remains considerable leeway to be made up before reaching the pre-war position. There had been further large increases in the cost of material and labour, but there had been no appreciable increase in the sale of electricity, although the receipts increased from £26,823 to £31,181, owing to the higher price. They were successful in their application for authority to increase the maximum rate of charge to 9d. per unit, and that higher rate had been in force in most of the towns since April, 1919. The balance brought forward was £180 more than in 1918, and the balance from wiring account was £450 greater. The gross profit was £12,428, compared with £6,178 in 1918, and including £654 brought forward from last year they had £13,082 to deal with. The interest and sinking fund on debenture stock required £5,500, leaving £7,582, and of the balance the directors recommended that £600 be applied to writing down investments, and that £6,500 be carried to reserve for renewal of plant, leaving £482 to be carried forward. The amount placed to reserve for renewal of plant, although substantially greater than in any previous year, was by no means too large in view of the inadequate amounts which it had been possible to set aside for the purpose during the last three or four years, and in view of the great increase in the cost of plant and machinery.

W. T. Henley's Meeting.

Mr. Geo. Sutton, who presided over the annual meeting of W. T. Henley's Telegraph Works Company, Ltd., on Friday last gave an analysis of the report and accounts (which were abstracted in our last issue). He said the balance of trading account was similar to that of the previous year; but the excess profits duty was a less percentage, and it had not been necessary to write so much off for depreciation of machinery, &c., because the war machinery depreciation had been dealt with. The carry forward to the general account was £20,000 larger, and there would be a carry forward of £141,000 against £122,000.

They had had more orders, both for home and overseas, than they could accept. They had never failed to recognise fully the need of exporting as much as possible, but their first consideration had had to be given to satisfying the demands from home buyers. Their output had been restricted by various causes, such as the delay in deliveries of raw material due to lack of transport, and the reduced hours of labour, which he could not say had up to the present resulted in increased efficiency. Their relations with their workpeople had been satisfactory. They had a Whitley Council for the cable industry, promoted by the Cable Makers' Association and the trade unions, and they had reason to hope that their relations with the unions representing their workpeople would keep them out of industrial turmoil.

The Future and Taxation.

As in the past year there had been abundance of work, so in the immediate future they did not doubt they could obtain all they could do; but for overseas trade—and it was overseas trade which was one of the principal sources of national wealth—there must be a reduction of the burden of present taxation if they were to reap any of the abundant harvest which the future promised. The conditions under which a manufacturing business had to be carried on were materially different from those in force prior to 1914. In some respects, such as the higher rates of wages, it might be that the present rates represented a minimum for the future years, but in regard to taxation he believed that it was essential to the success of their industries that they should not in the future be directly subjected to a taxation such as the excess profits duty. In 1914 they were taxed to roundly £12,000, and that would be about the rate for the previous 20 or 25 years. In 1919 they were taxed to £100,000, and that was much below the average of the war years. They had paid, or were liable to pay, for excess profits duty the huge sum of nearly £400,000. The amount paid in dividends had grown from £49,000 in 1914 to £69,000 in 1919, which was before deducting income-tax. Hitherto the company's business had relied for extension principally on undivided profits. From that source they had built new factories and extended their business throughout the world. That course had been of benefit to the nation, to the company, and to those in the company's service. It was a course adopted for their own advantage, but if the advantage were taken away by a severe limitation of profits, then nation and individual, capital and labour would be the poorer.

Mr. Sutton said the increase of profits shown in recent years did not give a good indication of the increase in business. Profits had decreased as a percentage on turnover, but the turnover had very greatly increased, both in quality and value, and that was a very healthy development. Increased capital was in former years derived from undivided profits, but, now taxation was so great, that source was to a large extent closed. They had large expenditure commitments in the coming months. They had embarked on an expenditure for new buildings and machinery to the amount of more than £150,000. They could get along for the moment without more capital. The business was showing abounding prosperity, the orders brought forward from last year, added to those received this year, were already in excess of the whole of last year's turnover. That had a direct bearing on their capital requirements, as also might have the provisions of the coming Finance Bill of the Government. The tire company might require more capital. They went off commercial work during the war, but they had already brought the factory's commercial work up to the level of the war work, or beyond. Everything pointed to the possible need of more capital, but their records and their reputation were such that no difficulties would present themselves.

The Mackay Companies.

The report of the trustees of the Mackay Companies states that the return of all telegraph, cable and telephone systems to their owners occurred on July 31, 1919, and the financial results of Mr. Burleson's administration of the telegraph and telephone lines for the year from August were somewhat disastrous to the Government. The postal telegraph-cable system earned during the year $4,029,195, but only $1,680,000 had been awarded as compensation. The gross receipts of the ocean and land line systems since their return from Government control have steadily increased, and the net profit, while not equal to the increase in gross receipts, due to the increased expenses incident to all classes of business, is quite satisfactory, although on Aug. 1, 1919, the land line system reduced the telegraph rate 20 per cent. by eliminating the 20 per cent. increase which Mr. Burleson put into effect on April 1, 1919, and which was only made necessary by reason of the excessive awards of compensation which he had made to the Bell Telephone and Western Union Companies. By careful and economical management the land line system is able to return to the old rate without loss and with sufficient profits to justify the continuance of such return, unless circumstances change. In August, 1919, by reason of the increased telegraph business, the trustees decided to string 24,000 miles of new copper wire between the commercial centres of the country, involving the purchase of about 5,000,000 lb. of copper wire. These new wires are being transposed as they are strung, and the long-distance telephone service is being constantly extended throughout the country. The Public Service Commission of the State of New York has ordered the Western Union Companies to accept messages from the Postal Company. After long drawn-out litigation, the landline company has succeeded in obtaining a right of way along the Florida East Coast Railroad from East Palatka to Miami, Florida, a distance of 304 miles. This will enable the postal system to reach many additional important cities and towns in Florida, and enable the system to lay a second submarine cable from Miami, Florida, to Havana, Cuba, a distance of 252 miles. The Supreme Court of the United States decided in the case of Postal Telegraph-Cable Company *v.* Warren-Godwin Lumber Company that the Acts of Congress have superseded State statutes and State decisions on interstate telegrams, so far as liability for damages in connection with the transmission of such messages is concerned. This decision will go far towards discouraging suits based on unavoidable errors or delays in the transmission of messages on account of storms, electrical disturbances, &c.

It has been decided to build a new cable repair ship to replace the cableship "Mackay-Bennett," which is now old. During the war the cable system, in common with other cable companies, suffered a good deal from reduced facilities, owing to the interruptions of its cables in deep water and within the war zones, which it was impossible to repair promptly owing to the control over the movements of cable ships by their respective Governments, and the danger of the lurking submarine. These reduced facilities, coupled with the enormous volume of Government messages, caused heavy congestion and consequent delay. The United States Government appointed a committee of technical experts to look into the methods of operating cables, with a view to increasing the carrying capacity, but the committee was not able to suggest any improvement that had not already been anticipated by your companies. At present a corps of expert mechanicians and electricians are engaged in experiment and trial of new devices, which give promise of increasing the efficiency of the existing cables and the trustees hope to be able to announce shortly the adoption of novel apparatus of a highly efficient order. The object aimed at is direct transmission between America and Europe at speeds equal to or better than the speeds obtained in indirect transmissions. The abolition of the censorship of cable messages on July 23, 1919, resulted in a resumption of the use of codes for condensing the length of messages; but, on the other hand, there was a large increase in the number of messages by reason of the freedom of cable facilities for commercial communication. The cable system consequently continues to handle a heavy volume of traffic, and, in fact, so heavy as to necessitate the consideration of laying additional cables between the United States and Europe as soon as reasonable and prompt delivery can be obtained.

New Companies.

AUROLITE ELECTRICAL SUPPLIES, LTD (165,924)—Private company. Reg. March 31, capital £3,000 in £1 shares, to manufacture and deal in apparatus and appliances for use in connection with electricity or gas. First directors are J. A. Ward, A. S. Gregg and J. F. Atkinson. Reg. office: Cromwell House, Surrey-street, Strand, W.C.

R. & S. BAXTER & COMPANY, LTD. (11,060).—Private company. Reg. in Edinburgh March 23, capital £5,250 in £1 shares, to carry on the business of miners of mica, manufacturers, merchants, brokers and agents of and for mica and mica goods, &c. First directors are: R. L. Baxter and S. L. Baxter, 31, Murraygate, Dundee, and A. B. Mudie.

C. T. BOWRING & COMPANY (WEST COAST AMERICA), LTD. (165,777)—Private company. Reg. March 27, capital £10,000 in £1 shares, to carry on in the United Kingdom or its colonies or dependencies, or in Chile, Peru or elsewhere, the business of manufacturers, importers and exporters of and dealers in plant, machinery, engines, hardware, electrical and mechanical engines, &c. The permanent directors are F. C. Bowring, Sir Edgar R. Bowring, Sir John B. Wimble, K.B.E., L. B. Stoddart, C. W. Bowring, E. H. Bowring and C. Bowring. A. Dick, of Lima, Peru, is the first ordinary director. Solicitors: Alsop, Stevens, Crooks & Company, 14, Castle-street, Liverpool.

CAHIR ELECTRIC SUPPLY COMPANY, LTD. (4,935).—Reg. in Dublin March 22, capital £6,000 in £1 shares, to carry on business as electrical engineers, suppliers of electric light, &c. Secretary: J. Moloney. Reg. office: Chapel-street, Cahir.

HOTPOINT ELECTRIC APPLIANCE COMPANY, LTD. (165,887)—Private company. Reg. March 30, capital £100,000 in £1 shares, to carry on the business of manufacturers and importers of and dealers in domestic, industrial and labour-saving devices and electrical appliances, engineers, &c. First directors are H. C. Lovis, W. C. Lusk and J. Gray. Sec.: A. F. Clements. Reg. office: 83, Cannon-street, E.C.

PATERSON MANUFACTURING COMPANY, LTD. (165,557).—Private company. Reg. March 22, capital £10,000 in £1 shares (4,000 preference), to carry on the business of electrical and mechanical engineers and contractors, electricians, &c. First directors are: T. Erndt, H. E. E. Ault and L. G. Clarke. Secretary: H. E. E. Ault, 75, Malvern-road, Thornton Heath.

PELABON, LTD. (165,900)—Private company. Reg. March 30, capital £250,000 in £1 shares, to take over the business of engineers carried on by C. Pelabon at Twickenham, and to carry on the business of mechanical, electrical, chemical and gas engineers, manufacturers of aircraft and aeronautical engines, &c. First directors are C. Pelabon (permanent) and others to be appointed.

PALMER RILEY & COMPANY, LTD. (165,386).—Private company. Reg. March 17, capital £10,000 in £1 shares. To take over the business of electical manufacturers and factors carried on by W. Palmer and J. E. Riley, as "Palmer, Riley & Company." First directors are: W. Palmer and J. E. Riley. Secretary: J. E. Riley. Reg. office: Market Chambers, Blackburn-road, Accrington.

READ & PARTNERS, LTD. (164,776).—Private company. Reg. March 3, capital £20,000 in £1 shares (10,000 preferred), to carry on the business of consulting, electrical, mechanical and general engineers, &c. First directors are H. J. Read (chairman), H. J. Butcher, W. J. Bransom and D. Dunham. Reg. office: 71, Caversham-road, Reading.

RIGLITE MANUFACTURING COMPANY, LTD. (165,849).—Private company. Reg. March 29, capital £5,000 in £1 shares, to carry on the business of electrical, mechanical, motor and general engineers. First directors are: C. H. Brown, W. R. Goodman, K. J. Goodman and T. Craig. Reg. office: 18, Cowleaze-road, Kingston-on-Thames.

WILLIAM ROMAN COMPANY, LTD. (165,815).—Private company. Reg. March 27, capital £10,000 in £1 shares, to take over the business carried on by G. F. Walker at Liverpool, and to carry on the business of agents for electrical and mechanical engineers, manufacturers of and dealers in electrical apparatus, engineering and shipping equipment. First directors are: G. F. Walker (managing director) and D. P. O'Brien. Reg. office: B16, Queen Insurance-building, Dale-street, Liverpool.

SHARP & COMPANY, LTD. (165,985)—Private company. Reg. March 31, capital £10,000 in £1 shares, to take over business of automobile electrical and general engineers and dealers carried on as "Sharp & Company." First directors are A. B. Sharp and A. C. Barker. Sec.: F. C. Barker. Reg. office: 17-21, West-street, Bromley.

WILL SMITH, LTD. (165,583).—Private company. Reg. March 20, capital £2,000 in £1 shares, to take over the undertaking of W. Smith, electrical manufacturers' agent, general electrician and contractor, of 24, Hampstead road, Liverpool. First directors are: W. C. Smith and T. Richards. Reg. office: 21 and 23, North John-street, Liverpool.

SOLAR ELECTRICAL COMPANY, LTD. (164,727.) Private company; reg. March 2, capital £2,000 in £1 shares (1,000 10 per cent. preference), to carry on the business of electrical engineers, electricians, dealers in electrical apparatus, &c. First directors are L. S. Challis and E. Kilpin. Reg. office, 53, Haymarket, S.W.

UNITED BRASSFOUNDERS & ENGINEERS (1920), LTD. (165,858)—Reg. March 29, capital £1,500,000 in £1 shares, to take over the business of the United Brassfounders & Engineers, Ltd., and to carry on the business of engineers, coppersmiths, &c. First directors are R. E. Hattersley, A. G. Smith, C. P. Newman, H. Greenleaves and S. J. Newman. Reg. office: Impress Foundry, Cornbrook, Manchester.

UNITED ELECTRICAL COMPANY (BIRMINGHAM), LTD. (165,910). Private company. Reg. March 30, capital £5,000 in £1 shares, to take over the business of engineers carried on at Birmingham by the United Electrical Company. Permanent directors: G. D. Mann, S. E. Sheerman and F. R. Pendergast. Reg. office: 47, Summer-row, Birmingham.

UNITED FACTORS, LTD. (165,859).—Private company. Reg. March 29, capital £10,000 in £1 shares, to carry on the business of motor, electrical, mechanical and general engineers, &c. Permanent directors are: E. H. Humphries and C. F. Dawes. Secretary (pro tem.): H. Palmer. Reg. office: 52-3, Snow-hill, Birmingham.

ARTHUR VALENTINE & COMPANY, LTD. (165,576).—Private company. Reg. March 23, capital £1,000 in £1 shares, to carry on the business of motor, electrical and mechanical engineers, manufacturers and repairers of and dealers in motor cars, &c. Secretary: A. W. Valentine, 58, Cauldwell-street, Bedford.

Prices of Metals, Chemicals, &c.

TUESDAY, April 13.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£112 0 0	—	£3 0 0
Electro Wirebars...	,,	£113 0 0	—	£4 0 0
H.C. wire basis......	per lb.	1s. 3⅜d.	—	$\frac{7}{16}$d.
Sheet	,,	1s. 5¾d.	—	⅛d.
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8⅜d.	$\frac{9}{16}$d.	—
Brass 60/40—				
Rod, basis	,,	0s. 11⅜d.	—	¼d.
Sheet, basis	,,	1s. 4¼d.	—	¼d.
Wire, basis	,,	1s. 3¾d.	—	¼d.
Iron—				
Cleveland Warrants	per ton	£10 7 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£48 10 0	£1 10 0	—
Lead Pig—				
English	,,	£42 0 0	—	£1 0 0
Foreign or colonial	,,	37 15 0	—	£2 5 0
Tin—Ingot	,,	345 0 0	—	£5 10 0
Wire, basis	per lb.	0 4 2½	—	1½d.

Salammoniac.—Per cwt. 105s.–100s.

Sulphur (Flowers).—Per ton £22.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £8 8s. 9d.

Copper Sulphate.—Per ton £48

Boric Acid (Crystals)—Per ton £74.

Carbon Bisulphide.—Per ton £56

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate.—Per lb. 5½d.

Rubber.—Para fine, 2s. 3d.: plantation 1st. latex 2s. 3d. per lb

Shellac.—T.N. Orange, 650s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

Forty Years Ago.

(THE ELECTRICIAN, APRIL 17, 1880.)

A DESERVED HONOUR.—Mr. James Sieveright, general manager of the telegraph between the Cape of Good Hope and Natal, has been gazetted to the most distinguished Order of St. Michael and St. George for services rendered in South Africa.

KING'S COLLEGE.—We understand that Prof. W. G. Adams, F.R.S., will give a course of lectures during the ensuing term on "Electrical Testing as Applied to Telegraphy." The lectures will be given on Fridays, commencing 23rd inst. The practical work will take place on Tuesdays. Students may attend one or both classes.

SHEFFIELD TELEPHONE EXCHANGE.—We understand that the Sheffield Telephone Exchange Company intend applying to the Corporation for permission to fix in the immediate vicinity of one of the central cab stands a small signal box, so that subscribers may be able to call a cab or hansom at any moment, either from their place of business or their residence.

TELEGRAPHING THE RESULT OF THE MIDLOTHIAN ELECTION.—Great activity prevailed at the General Post Office as soon as the result of the poll had been declared. The telegraph department was immediately besieged by people eager to despatch the news to friends in different parts of the country. This extra bustle had, of course, been anticipated and provided for; and in the course of the evening close upon 2,000 private telegrams were despatched with remarkable facility and expedition.

THE APPLICATION OF ELECTRICITY TO MILLING PURPOSES.—A public exhibition was given to New Haven on March 13, of an electric middlings purifier, the joint invention of two young men of that city. The working of the device is said to have been highly promising. Over the wire-bolting cloths is placed a bank of hard rubber cylinders, which are slowly revolved against strips of sheep skin and thus electrified. To these rollers the light bran is attracted, to be mechanically brushed into a proper receptacle. This substitution of electric attraction for the air blast in separating bran from flour is said to lessen the waste, while it obviates the necessity of doing the work in a closed chamber and the risk of explosions.

THE FIRST ENGLISH ELECTRICAL PATENT.—The pioneer electric patent for the United Kingdom is No. 1,318, dated 1782, for "Electrical Machines," and taken out in the name of Edward Nairne. The specification begins, "To all to whom these presents shall come, I, Edward Nairne, of the Parish of Saint Michael's, Cornhill, in the City of London, optician, send greeting. Whereas his most excellent majesty King George the Third by his Royal Letters Patent under the Seal of Great Britain, bearing date at Westminster, the Fifth day of February in the twenty-second year of his reign, did give and grant unto me, that I, the said Edward Nairne, my executors, administrators, and assigns, should at any time agree with and no others, from time to time, and at all times hereafter during the terms of years therein expressed, should and lawfully might make, use, exercise, and vend within that part of his kingdom of Great Britain called England, his dominion of Wales, and town of Berwick-upon-Tweed, my 'new invented and most useful improvement in the common electrical machine (which I call the insulated medical electrical machine), by insulating the whole in a particular manner, and constructing the conductors so that either shocks or sparks may be received from them.'" The specification can be purchased for the sum of 3d. at the office for the sale of such papers in Cursitor-street, Chancery-lane.

ELECTRIC LIGHTING.—The Victoria Docks and Holyhead Harbour are to be lighted by electricity. The Royal Navy is adopting Brush's light. Siemens' light has been introduced into the Siam Dispensary, Bangkok, as a rival to Jablochkoff's. South Kensington Museum is also, we hear, to be lighted by the Brush system. The arrival of spring has brought with it a discontinuance of Siemens' light in the reading room of the British Museum until next autumn. The authorities regard it as a good success.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics":—"The Inter-Allied Commission: Disquieting Information from Germany" (special); "Elementary Principles of Aeroplane Design," by Col. J. Morris and Major-General Sir F. H. Sykes ("Pioneers of Aviation" series).

"Cabinet Maker":—"Small Folding Tables"; and "Woodwork at the Building Trades' Exhibition."

"Chemical Age":—"Notes on the Nitrate Industry of Chile"; "Microscopy and Biology in Industry," by F. A. Mason; and "Nitrogen Fixation Experiments in America."

"The Fruit-Grower":—"Forcing Roses"; "Notes on Some Fungus Diseases," by F. S. Salmon; and "Wages and Hours of Agriculture."

"The Gas World": "Allocation of Manufacturing Costs and Costing of Work"; "Performance and Management of Gas Engines"; and "Benzole as a Motor Fuel."

"Hardware Trade Journal":—"Labour Saving in the Foundry" (No. 8), by Joseph Horner; "France as an Iron and Steel Producer" and "American Competition in the Hardware Trade."

"Ways and Means":—"The State of Exchange and Foreign Opinion," by The Editor; "Housing in Yorkshire," by W. R. Bayes; and "Some Sociological Aspects of the Present Industrial Position," by Professor Urwick.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF
ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE
ESTABLISHED 1861.

No. 2,188. [Vol. LXXXIV. No. 17.] FRIDAY, APRIL 23, 1920. PRICE ONE SHILLING.
By Post, 1s. 1d. Abroad, 1s. 2d.

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Notes.

The Budget.

One provision in the Budget introduced by Mr. Austen Chamberlain on Monday last will come as a great shock to financial and commercial interests. So far from the Excess Profits Duty having been dropped or at least reduced, it is to be increased from 40 to 60 per cent. as from January 1 last. In addition a new tax of one shilling in the pound on all profits exceeding £500 a year is to be imposed on limited liability companies. In assessing this tax any excess profits duty payable will be treated as a working expense. This looks suspiciously like a breach of faith. The Federation of British Industries accepted the principle of a tax on profits in substitution for the Excess Profits Duty. But it was not expected that the new tax and the old would run concurrently or that the maintenance of the latter would depend on whether some workable form of capital levy could be found as is now suggested. Postal, telegraph and telephone rates are all increased because the Post Office is not paying its way; and there is also an increase in the taxes on mechanically-propelled vehicles, to which we refer more particularly below. To these two latter classes of taxes and to the increases on wine, beer and spirits serious exception can hardly be taken, though personally we should like to have seen the postal rates left alone. For a large revenue is necessary not only to meet the ever-increasing expenses of administration, which to some extent are justifiable, but also to make a start at paying off our war indebtedness.

The Strangulation of Trade.

It should be obvious, however, that this indebtedness can only be liquidated by increasing the trade and so the prosperity of the country. To continue the Excess Profits Tax or even to replace it by a capital levy is like putting a man to work with a halter round his neck: both his peace of mind and his efficiency must suffer. This new imposition is greatly resented in commercial circles, and we should not be surprised to see it modified. It is particularly harsh in its operation on young and expanding businesses, though in our present struggle to return to something like our old prosperity it is precisely such businesses that require assistance. To sap the life-blood of industry in this way is most harmful. The only advantage we can see in this unfair tax is that it may recall the House of Commons to their duty of supervising the expenditure of the Government Departments and so put an end to the waste of our national resources which is still the principal occupation of our new bureaucracy. Grandiose schemes must be dropped, attractive projects for new spending curtailed, and all efforts directed to real retrenchment. To extract money from the public and to spend it as it is being spent at present is more like highway robbery than high finance.

The Southampton Dispute.

The ever-recurring disputes between the E.P.E.A. and the E.T.U. (we use the initials for sake of brevity in these days of paper shortage) are quickly reducing the station engineers involved to the position of the man who interferes in a quarrel between husband and wife. Whoever else emerges scathless he certainly does not. Mr. Harry Ellis, borough electrical engineer of Southampton, is the latest victim. For nearly a week, with the aid of his chief assistant, his station superintendent and a few volunteers, he maintained a supply of electricity for lighting in Southampton, was able to give power consumers practically their full requirements, and after the first few days of the strike added a gradually increasing tramway service. When we consider the dangers to which the inhabitants of a town like Southampton would be exposed by the withdrawal of public lighting, let alone the real inconvenience suffered by private consumers in like circumstances we cannot too highly commend Mr. Ellis and his associates' devotion to duty or deplore too deeply the callousness shown by the members of the E.T.U. in withdrawing their labour at a moment's notice.

E.P.E.A. or E.T.U.?

The cause of the dispute is simple, even trivial. Mr. Hooper, a member of the E.T.U., was recently promoted from the position of charge engineer to station superintendent. His position brought with it the control of men belonging to other trade unions He consequently resigned from the E.T.U. and joined the E.P.E.A. The points to which this action give rise are set out by Mr. W. A. Jones, general secretary of the E.P.E.A., in another column of this issue and need not be discussed here. It will be sufficient to say that local branch of the E.T.U. apparently without communicating with their own headquarters, and certainly without communicating with the E.P E.A., called their members at the electricity station out on strike because they objected to Mr. Hooper's action. We agree with Mr. Jones that this demand by a trades union to the right to determine to what union a man should belong is coercion of the worst kind and incidentally coercion to which the E.T.U. would have objected, if it had been applied to them. The question is not a trade dispute in the true sense of the word and the strike is not the proper method to use for settling it.

Fresh Complications.

Up to this point, except for Mr. Ellis, the points were simple and the issue clear. To keep the station running Mr. Ellis engaged certain members of the E.P.E.A. as engine room staff and took on fresh stokers to replace the members of the British Seafarers' Union who had come out in sympathy with their friends in the E.T.U. The result is that the service in Southampton has gradually improved and is now normal. Towards the end of last week, seeing apparently that nothing was to be gained by further negotiations,the E.T.U. decided to drop its demand for Mr. Hooper's resignation and instructed their members to return to work. But the Electricity Committee quite rightly refused to break their pledged word to the men they had taken on. A mass meeting of the Trades Unionists therefore decided to call a general strike at midday Tuesday unless an honourable settlement, in other words, a giving way to their demands was made by that time. The Town Council sat through Monday night negotiating with the Strike Committee, and finally agreed to reinstate all the strikers and to give the men taken on in their places two months' wages in lieu of notice. Thus a general strike has been avoided, and the case of Mr. Hooper is to be the subject of negotiations between the E.P.E.A. and the E.T.U. as it might, and should, have been in the first instance. The strike has cost the town several thousand pounds and dislocated the industries of the port. And no one, not even the E.T.U., is a whit the better.

The Taxation of Electric Vehicles.

The interim report of the Committee appointed by the Minister of Transport to consider the question of the taxation of and regulations affecting road vehicles, places both the electric pleasure car and the electric commercial lorry in a very favourable position with regard to petrol-operated vehicles. The recommendations are adopted in the 1920-21 Budget. It is proposed to abolish the motor spirit duty, to take horse power as the basis of taxation in the case of the private car, unladen weight in the case of commercial vehicles and seating capacity in the case of hackney vehicles, including tram cars. Electric pleasure vehicles, however, are only to be taxed at the minimum rate of £6, whatever their horse-power, while petrol-driven vehicles pay at the rate of £1 per horse-power. The difference in the case of the larger powered cars is therefore obvious. The difference becomes the more evident when the low-running costs of the "electric" are taken into consideration, and the only obstacle to an immediate development of the electric pleasure vehicle in this country would seem to be the inability of the manufacturers of this class of goods to turn out sufficient pleasure and commercial vehicles simultaneously.

Where the "Electric Commercial" Scores

Matters are equally favourable where the taxes proposed on commercial vehicles are considered. The basis in the case of the "electric" is its unladen weight, less the weight of the battery. The effect of this may be gathered by comparing the weight of a standard 3-ton War Department petrol vehicle, which, in practice, weighs about 4¼ tons unladen, with a 3½-ton electric vehicle, whose weight under the same conditions is generally between 4 and 4½ tons. Of this weight the battery accounts for about a ton, so that the taxable weight of the average 3-ton electric vehicle is about 3¼ tons, as against 4¼ tons for the petrol vehicle. The result is that the former pays a £28 tax, and the latter a £30 tax. This, it will be agreed, is equitable if the small wear caused to the road surface by the "electric," owing to its low speed and uniform turning effort on the driving wheels are taken into account. On these grounds a case might have been made out for even greater concessions, but we understand that there was a hard fight even to have the weight of the battery excluded. The only case where the "electric" is not favoured is in the hackney vehicle section, where both it and petrol vehicles pay the same tax. If these recommendations are accepted there is every hope of a large development of the electric vehicle, and we shall welcome propaganda to this end. Owners of electric vehicles have indeed very little to object to, but it is only right to add that owners of petrol vehicles are protesting strongly. In addition, tramway undertakings will have to pay a tax of 15s. per car, which will be an additional charge at a time when it can ill be borne.

The Labour Situation.

Apart from the position at Southampton, the Labour situation is not much worse than it was last week, and it is certainly not much better. Little progress has been made in the tramways dispute. The Joint Industrial Council was to meet yesterday (too late to deal with the matter in this week's issue), when a new claim put forward by the men will probably be considered. This is in effect a proposal to leave the 6s. increase in the war wage already agreed upon as it stands, and to add 1d. an hour to the pre-war wage. This would give each man an extra 4s. a week. During the week this proposal has been discussed by the Joint District Councils, and while the larger towns are willing to do something in this direction, many of the smaller undertakings point out that any further increase would make them insolvent. Moreover the whole question bristles with anomalies when comparisons are made with conditions in other trades. And over everything broods the threat of a general strike. We hope saner councils will prevail, but there is a good deal of irritation which tends to make settlement difficult. As was expected, the result of the miner's ballot was to veto the strike, but there has been a stoppage in South Wales. The railwaymen are demanding an extra £1 a week in addition to the advance under the sliding scale, because, as Mr. Cramp puts it, "it is clearly the duty of railwaymen to see that their rates are advanced" when there is an advance in other industries. Mr. Cramp accuses the Government of sharp practice over the withdrawal of the bread subsidy, but that kind of dealing does not seem to be confined to one side. Workers in the chemical, clay, engineering, foundry, explosive, shipbuilding and other trades are also preparing to put forward fresh demands. The only bright spot is a statement issued by the Clerks' Union pointing out that further demands for increased wages can only increase the cost of living in greater proportion. Mr. J. H. Thomas is said to be beginning to take this view. If he only can impose it on the men he leads some improvement might result. But we doubt his power to do this.

Sir Tom Callender—Optimist.

In these days of Budgets, strikes and other problems of peace, it is refreshing to listen to an optimist. Certainly Sir Tom Callender, addressing the Batti-Wallahs Society at their monthly luncheon on Monday last, is not the type of optimist who has been described as a man who has just been talking to a pessimist. Referring to electrical developments on ship-board, Sir Tom spoke of the many improvements introduced during the war, and of the good prospects of work in the immediate future in all our shipyards. The problems of ship propulsion, though not specially an engineering subject, were being successfully tackled. Experiments were made during the war whereby vessels of all classes, but particularly liners, were guided into port by means of leader cables; in this direction also wireless was playing a valuable part in assisting navigation during foggy weather. There were also prospects of the extension of the use of electricity in the Navy: the war having contributed largely to our knowledge in this direction. Turning to the Electrical Industry, Sir Tom Callender—as a result of extensive business tours abroad—spoke most optimistically of the work of British engineers. In spite of loud trumpeting to the contrary, the Germans were behind us, and America was in the same place. Sir Tom recently asked an American in the States to account for the industrial unrest in that country, and he received the naive reply: "Waal you see, we've been at war the last two years." One of the most priceless jokes we have heard for a long time! There was in prospect a considerable increase in electrical development, which would come about where it was least expected. Quite apart from what was ahead we did not realise the enormous amount of work that had been done in this country, particularly with electric power supply. Sir Tom altogether took a refreshingly hopeful view of electrical prospects, and we ourselves believe that his optimism will be justified.

The Development of the Electrical Industry.

But it is probably better to be a pessimist than an optimist. For the latter is often disappointed, while things sometimes turn out better for the former than he expected. From this point of view Mr. A. F. Berry must be classed as a pessimist. At a recent meeting of the preference shareholders of the British Electric Transformer Company, he expressed himself as surprised at the extent to which the electrical industry had grown, and quite rightly ascribed this to the unceasing energy of those connected with it. We think, however, that the development of the electrical industry is greater than Mr. Berry supposes. He puts the amount invested down as £150,000,000. This surely refers to the manufacturing interests alone. For if we take the industry as a whole, including, that is, supply, tramways and telegraphy, the sum invested, according to the latest edition of "Garcke's Manual," is nearer £600,000,000 than the sum given by Mr. Berry, which is probably an under-estimation. And it is as a whole that the electrical industry should be considered. Sectional interests and desires must give way to work for the good of the whole. It is only in this way we can hope to advance at the same rate in the future, as we have done in the past.

A University Prospectus.

One of the elements of success in both warfare and business is surprise. Mr. Sydney Walton is, therefore, to be congratulated on finding a new method of appealing to the charitable; and we hope his enterprise will be rewarded in the way he would most wish. There is something attractive about a Company prospectus, even to those who have no money; and it is therefore likely that few of those who receive the neat folder entitled "Lancashire Development Unlimited," will consign it to the waste paper basket unread. When they open it they will find that it is an appeal for £500,000 for the very necessary development of the activities of the University of Manchester. Of this, £171,000 will be absorbed for objects to which the University is already committed, including a sum of £30,000 for the reconstruction and equipment of the scientific departments, £13,000 to pay off debts on existing buildings, and £8,000 for making good deficiencies in equipment. Further funds are required for the general extension of the University buildings, and for hostel accommodation for the students. "I call a complete and generous education," says Milton, "that which fits a man to perform justly, skilfully, and magnanimously all the offices, both private and public of peace and war." That is a great ideal, but it cannot be obtained without endowment. Let England, therefore, and especially Lancashire from its present prosperity, come forward and generously pour out funds to assist that great teaching institution established in that northern city. Copies of the prospectus may be obtained from Mr. George Marriott, 9, Albert-square, Manchester.

Conjoint Board of Scientific Societies.

Their third Annual Report shows that the Conjoint Board of Scientific Societies is continuing to do useful work. Interest in the important subject of the Water Power of the Empire has been stimulated, and local Commissions are being set up in India, Ceylon, British Guiana, Australia, and South and East Africa to estimate the water power available in those countries. We welcome the suggestion to hold an Imperial Water Power Conference in London, and the attention that is being drawn to the lack of facilities for training in hydro-electric engineering. Efforts are being made to obtain better and more centralised accommodation for technological and scientific societies. A step in this direction might be made by returning the buildings belonging to such Societies, which are now in the possession of the Government. But in addition what is wanted are premises which can be used both for large and small meetings, and as a club on the lines of the well-known Engineering Building in New York. The new patent laws, and the metric system are receiving attention. Altogether the Conjoint Board is justifying its existence.

Engineering and Adventure.

Men associated with science are apt to cry out at the dry-as-dust methods employed by educationists in other fields, and to point to the unenterprising and routine form of mind that academic and particularly classical education, is supposed to provide. It is, therefore, interesting to notice an address of quite an inspiring nature on "Engineering and Adventure" recently delivered by Mr. P. B. McDonald, Professor of English at the School of Applied Science in New York University. Mr. McDonald, although himself a lecturer on what may be considered an "academic" subject (but it is certainly an extremely important one), shows familiarity with the broad trend of thought of engineering minds. Briefly, his address is a plea for a return to individualism as compared with excessive adherence to system. He contrasts the enthusiasm of the craftsman in the Middle Ages with the uninspired and grudging effort of most workers in factories to-day, and he contends that the methods imposed by the older generation tend to kill much of the initiation and enthusiasm of young engineers entering on their profession. A young man taking up engineering is not swayed mainly by hope of pecuniary reward. Engineering to him offers a prospect of romance and intellectual adventure. Industrial officials, however, frown upon adventure and regard it as an additional reason for rendering methods and machinery "foolproof." With much that Mr. McDonald says, many of us will agree. The deadening nature of our present office and factory methods are largely responsible for the general industrial unrest. And there is everywhere a natural bias in favour of the safe course rather than the adventurous one. Contrary to expectation the war seems to have rather accentuated this bias. On the whole, absence of competition and insatiable demand for standard articles has led manufacturers into ruts. And, once a system is established, the immediate prospect of good earnings through systematised production on familiar lines closes the mind against adventurous experiments with new processes. From a purely commercial standpoint this attitude is often right, but not always so. Commercial success, which depends on cheap standard production is sometimes precarious. Once adopted mass production methods are difficult to modify, and success may be undermined by new discoveries to which they cannot easily be adapted. On the other hand, success based on the unique possession of a valuable scientific or technical discovery is usually more enduring, and certainly less arduous to maintain. Seeing that we in this country are so often accused of extreme conservatism, it is curious to notice the dictum of a Harvard professor that the American inventor will not take the chances that an English inventor will : "We are not so adventurous or so individualistic as the English." Uncertain as is the present economic situation, we hold that the present period is one offering great inducements to bold adventure, and trust that the mental disposition attributed to us will enable these opportunities to be grasped.

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Research and Military Electric Lighting.

Tucked away in a corner of the Army Estimates are two items which should be of interest to electrical engineers. A sum of £3,845 is put down for the School of Electric Lighting, as against £18,959 last year, while to the Anti-Aircraft Searchlight and Sound Location School £1,785 is allocated, as against £13,200. The large reduction in the requirements of both these institutions is, of course, mainly due to demobilisation of the war strengths. But it is not of this we wish to speak. The work of these schools is largely instructional, but in addition they perform very useful functions in what in civil life would be called research. When we went into the war we knew little about searchlights, and less about anti-aircraft defence. During the war we learnt a great deal about both these subjects. It is to be hoped that now that peace and quietness have descended on our fighting forces, this information will be sifted, and what is useful employed as a basis for future progress. In this matter we can learn not only from our own mistakes, but from those of our Allies and the enemy.

Current Topics.

Subjects of interest dealt with in the current issue include the following :—

On p. 441 we give a further instalment of Mr. H. H. Broughton's article on "Electric Winding Engines and Mine Hoists."

We publish an article by Capt. W. T. Taylor on "Water Power and the Coal Problem," in which he lays down certain directions in which economies in the use of coal might be effected (p. 444).

On p. 443 we give a short abstract of a Paper read by Mr. J. F. L. Vogel on the "Tungsten Industry."

An account of the recent meeting of the Advisory Committee of the International Electrotechnical Commission at Brussels is given on p. 445.

A description of an interesting electric baling press made by Messrs. Hindle Sons & Company appears on p. 446.

On p. 448 we give an abstract of a Paper recently read before the Institution of Electrical Engineers by Major C. E. Prince on "Wireless Telephony on Aeroplanes."

An account of the discussion opened by Mr. S. J. Watson, which recently took place at Manchester on the question of Electricity Supply Tariffs is given on p. 450

On p. 451 Mr. J. Scott-Taggart describes a new electric lamp rectifier.

Our correspondence columns contain a letter from Mr. D. C. Meffan criticising certain conclusions come to by Mr. Alan Kirk in his article on "Wiring for Electric Lighting in Small Houses," which appeared in last week's issue of The Electrician; and a letter by Mr. W. A. Jones dealing with the dispute between the E.P.E.A. and the E.T.U. which has arisen at Southampton (p. 452).

Our Leading Article criticises the education estimates for 1920-21 (p. 453).

Arrangements for the Week.

FRIDAY, April 23rd (to-day).

Physical Society.

5 p.m. At the Imperiall College of Science, S. Kensington, London, S.W. Fourth Guthrie Lecture on "The Anomaly of the Nickel-Iron Alloys; its Causes, and its Applications," by Monsieur C. E. Guillaume.

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, London, S.W. Papers to be read :—"On the Hardening of Screw Gauges with the Least Distortion in Pitch" (referring to Water Hardening) and "On the Hardening of Screw Gauges with the Least Distortion in Pitch" (referring to Oil Hardening), by the late Mr. W. J. Linehan, revised by Mr. G. T. White.

Institution of Electrical Engineers, North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle-on-Tyne. Kelvin Lecture on "Modern Marine Practice," by Dr. C. V. Drysdale.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Modern Developments in Motor Car Design," by Mr. R. S. Fox, M.A.

SATURDAY, April 24th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "The Thermionic Vacuum Tube," by Prof. W. H. Eccles, D.Sc. (Lecture II.)

MONDAY, April 26th.

Electrical Trades' Benevolent Institution.

2.30 p.m. At the Offices of the Electrical Contractors Association, 11, Southampton-row, London, W.C. Annual General Meeting.

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Aluminium and Its Alloys," by Dr. W. Rosenhain, F.R.S. (Lecture III.)

TUESDAY, April 27th.

The Dynamicables.

7.15 p.m. At Connaught Rooms, Great Queen-street, London, W.C. Anniversary Dinner.

Institution of Electrical Engineers, N.-Western Students' Centre.

7.30 p.m. At Houldsworth Hall, Deansgate, Manchester. Annual General Meeting.

THURSDAY, April 29th.

Institution of Electrical Engineers.

6 p.m. At Great George-street, London, S.W. Paper on "Automatic Protective Devices for Alternating Current Systems," by Mr. A. E. McColl.

Association of Engineering and Shipbuilding Draughtsmen.

7.30 p.m. At the Grammar School, Chesterfield. Lecture on "Gas Producer Plant," by Mr. J. J. Nicholson.

FRIDAY, April 30th.

Wireless Society of London.

6 p.m. At the Institution of Civil Engineers, Great George-street London, S.W. Paper on "A Wireless Call Device," by Majo Basil Binyon, O.B.E.

N.-East Coast Institution of Engineers and Shipbuilders.

6.15 p.m. At the Literary and Philosophical Society, Westgat road, Newcastle-on-Tyne. Paper on "A Modern Power Station and its Development," by Mr. J. S. Watson.

Institution of Electrical Engineers, Students' Meeting.

7 p.m. At Faraday House, Southampton Row, London, W.C Paper on "Tidal Power," by Mr. J. E. Holmstrom.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Social Evening.

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from p.* 392.)

GEARED THREE-PHASE WINDER FOR AN INCLINED SHAFT OF VARYING SLOPE.

A simple extension of the method described in the preceding section for the winder operating in an inclined shaft of uniform slope may be used for shafts of varying inclination. As an illustration we propose to consider a 10,000-lb. rock hoist for the shaft depicted in Fig. 9. The principal data of this hoist are:—

Nett load	10,000 lb.
Skip	6,000 lb.
Shaft	(*See* Fig. 70.)
Output per hour	95 tons.
Maximum speed	2,000 ft. per min.
Rope	$1\frac{1}{2}$ in. dia.; 3·55 lb. per ft.
Drums.—Twin cylindrical, each 14 ft. dia.;	$\frac{WR^2}{g}=145{,}000$.
Interval	20 sec.
Sheaves	16 ft. dia.; $\frac{WR^2}{g}=8{,}000$ [each.
Motor	375 r.p.m. (theoretical).
Rolling friction	Angle $3\frac{1}{2}$ deg.
Shaft friction	6% of load+2 skips.
Rope friction	5 per cent.

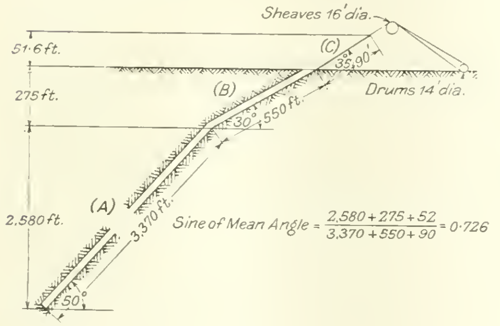


FIG. 9.—BENT INCLINED SHAFT.

Approximate Output of Motor.—A load of 10,000 lb. is moved at a speed of 2,000 ft. per min. along a slope having a mean angle of inclination of $\sin^{-1}=0{\cdot}726$ Hence the probable rating of the motor is

$$\text{H.P.}=\frac{10{,}000\times0{\cdot}726\times2{,}000}{33{,}000}\times2{\cdot}2=1{,}000.$$

Referring to Table II. the inertia of the rotor of a 50-cycle motor of this size is 1,238.

A speed of 2,000 ft. per min. corresponds to a drum speed of $2{,}000\div14\pi=45{\cdot}5$ revs. per min., and the gear ratio $=365\div45{\cdot}5=8$ to 1.

Sub-division of Cycle.—An output of 95 tons per hour necessitates $95\times2{,}240\div10{,}000=21{\cdot}3$ winds per hour at 10,000 lb. per wind. Calling this 22, the time per trip $=3{,}600\div22=164$ sec., and deducting 20 sec. for the interval we get 144 sec. for the nett winding time.

Since the total length of the shaft $=3{,}370+550+90=4{,}010$ ft., it follows that the equivalent full-speed value of the run $=4{,}010\div33{\cdot}3=120$ sec., and the time available for starting and stopping $=2\ (144\times120)=48$ sec. Of this time 20 sec. will be allowed for starting, and 28 sec. for stopping. The duration of the constant-speed run $=144\times48=96$ sec.

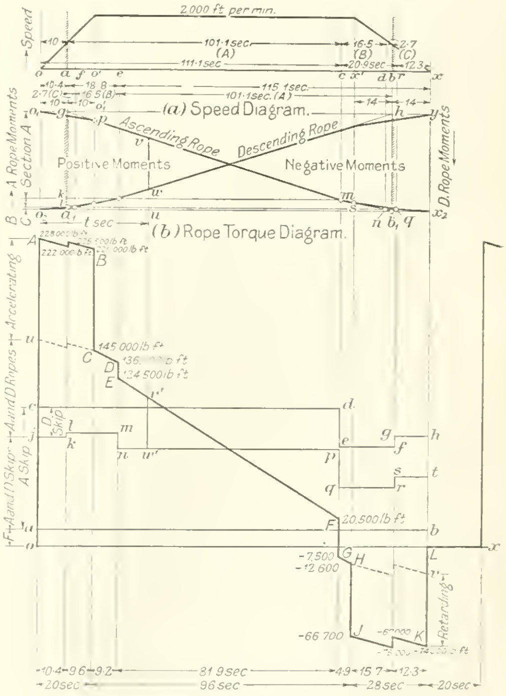
Distances Moved Through.—During acceleration the skips are moved through a distance of $\frac{1}{2}\times20\times33{\cdot}3=333{\cdot}3$ ft. The distance moved through during constant speed $=96\times33{\cdot}3=3{,}200$ ft., and during retardation the distance traversed $=\frac{1}{2}\times28\times33{\cdot}3=466{\cdot}7$ ft.

Torque Diagram.—The several loads will be dealt with in the following order:—Shaft and rope friction, ascending load and skip, descending skip, ascending and descending ropes. Having found the resultant static moment, the diagram will be completed by taking into account the accelerating and retarding moments.

Shaft and Rope Friction.—Reckoning shaft friction at 6 per cent. of the weight of the ascending and descending skips at the drum radius, the corresponding torque

$$\begin{aligned}&=(10{,}000+(2\times6{,}000))\times0{\cdot}06\times7\\&=9{,}240\text{ lb. ft.}\end{aligned}$$

The total weight of rope in the shaft is constant throughout the wind and equal to $4{,}000\times3{\cdot}55=14{,}200$ lb. The reaction is $14{,}200\times0{\cdot}643=9{,}100$ lb. and the rope friction is assumed to be 5 per cent. of this reaction, or 455 lb. at the drum radius. The torque, therefore, is $455\times7=3{,}185$ ft.



(*c*) Total Torque Diagram.

FIG. 10.—DIAGRAMS FOR BENT INCLINED SHAFT.

Referring to Fig. 10(*c*), a length *oa* is marked off to represent a torque of $9{,}240+3{,}185=12{,}425$ lb. ft. and the line *ab* is drawn parallel to the base.

Ascending Load and Skip.—From Fig. 9 and Table VII. it will be seen that as long as this skip is in the portion *A* of the shaft, the rope pull $=(10{,}000+6{,}000)\times0{\cdot}805=12{,}900$ lb.

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Section.	Length L, ft.	Weight, $W = 3·55L$ lb.	Inclination, θ deg.	Sin θ.	Rope-pull, $P = W \sin\theta$, lb.	Moment $= 7P$ lb.-ft.	Ideal time, $t = L/v$, sec.	Actual time.	
								Ascending, sec.	Descending, sec.
A	3,370	12,000	50	0·766	9,200	64,300	101·1	111·1	115·1
B	550	1,950	30	0·500	975	6,820	16·5	20·9	18·8
C	90	320	35	0·574	184	1,290	2·7	12·3	10·4
					Total	72,410	120·3	144·3	...

The loaded skip starting at the bottom of the shaft moves through a distance of 333·3 ft. in 20 sec., and the time required to move the skip through the remaining length of (3·370 − 333·3) ft. at 33·3 ft. per sec. = 91·1 sec. Hence the total time taken to traverse the whole of the 3,370 ft. length = 20 + 91·1 = 111·1 sec.

Therefore for 111·1 sec. from the commencement of the wind the constant moment due to the ascending load and skip = 12,900 × 7 = 90,300 lb. ft. This is represented by the line cd, Fig. 10 (c), and is marked off to the base ab so as to include the friction moment previously determined.

During retardation the skips move through a distance of 466·7 ft. In other words retardation begins on the ascending side when the skip is (466·7 − 90) = 376·7 ft. from the end of section B of the shaft, so that the first (550 − 376·7) = 173·3 ft. are moved through at a constnat speed of 33·3 ft. per sec. in 173 ÷ 33·3 = 5·2 sec. The time taken to traverse the remaining length of 376·7 ft. is 15·7 seconds*, and the total time taken by the ascending skip in traversing the entire section B of the shaft is 5·2 − 15·7 = 20·9 sec.

Therefore, during the 20·9 sec. taken in traversing section B the constant moment due to the ascending load and skip = (10,000 + 6,000) × 0·553 × 7 = 62,000 lb.ft. This moment is marked off to the base ab as before and is represented by the line ef in Fig. 10 (c).

The time taken to traverse section C of the shaft is obviously (28 − 15·7) = 12·3 sec., and the moment during this time is (10,000 + 6,000) × 0·624 × 0·7 = 70,000 lb. ft., which is represented by the line gh in Fig. 10 (c).

Hence the stepped line c.........h referred to the base ab represents the moment due to the ascending load and skip.

Descending Skip.—At the beginning of the run this skip is at the top of the shaft. In 20 sec. the skip acquires a speed of 33·3 ft. per sec., so that the acceleration = 33·3 ÷ 20 = 1·67 ft. per sec. It, therefore, takes 10·4 sec. for the skip to traverse the section C of the shaft, and during this time the constant moment is 6,000 × 0·521 × 7 = 22,000 lb. ft. In Fig. 10 (c) this moment, represented by the line jk, is plotted downwards on the stepped base c.........h since it is of opposite sign to the moments dealt with up to the present.

As regards section B, the first (333·3 − 90) = 243·3 ft. are traversed in a time of (20 − 10·4) = 9·6 sec., and the remaining (550 − 243·3) = 306·7 ft. are moved through at a constant speed of 33·3 ft. per sec. in 9·2 sec. The total time taken in traversing this section of the shaft is, therefore, 9·6 − 9·2 = 18·8 sec. As long as the descending skip is in this portion of the shaft the moment = 6,000 × 0·447 × 7 = 18,800 lb. ft., and this moment, which is shown by the line lm in Fig. 10 (c), is plotted as a negative quantity to the stepped base c.........h as before.

Finally the last 466·7 ft. of section C of the shaft are traversed in 28 sec. and the time taken to traverse the first (3.370 − 466·7) = 2.903·3 ft. at a constant speed of 33·3 ft. per sec. is 87·1 sec., so that the total time taken to move the descending skip along the entire section C of the shaft is (28 − 87·1) = 115·1 sec., and during the whole of this time the moment = 6,000 × 0·727 × 7 = 30,500 lb. ft. This is represented by the line tepped line n.........t in Fig. 10 (c).

The stepped line j.........t to the base ox represents the moment variation due to the ascending and descending skips, taking rolling, shaft and rope friction into account. To complete the diagram of static moments, the moments due to the ascending and descending ropes have to be added.

Ascending and Descending Ropes.

The resultant moment due to the ascending and descending ropes will be determined by an extension of the graphical method described previously.*

In the first place, a table is prepared showing the length, weight, inclination, pull and moment of each section of rope in the shaft. For the winder under consideration, the particulars referred to are set out in the accompanying table.

Referring to Fig. 10 (a), the speed is plotted to a time base. The two perpendiculars shown cross-hatched are erected at a distance apart, ab, equal to the equivalent full-speed value of the run—namely, 4,010 ÷ (100/3) = 120·3 sec., the first perpendicular being distant half the accelerating period from the beginning of the wind. It follows that the second perpendicular is distant half the retarding period from the end of the wind. Along the base ab the ideal times for the ascending rope are marked off from left to right. Thus, ac = 101·1 sec., cd = 16·5 sec., and db = 2·7 sec. The ideal times are also marked off from right to left for the descending rope, and are represented by bc, ef and fa. We shall confine our attention to the ascending rope.

To construct the torque diagram for this rope, draw a_1b_1, Fig. 10(b), parallel and equal to ab, Fig. 10(a). At a_1 and b_1 erect perpendiculars a_1g and b_1h, each equal to the total rope moment of 72,410 lb.-ft. Along ga_1 mark off lengths gk, kl and la_1 to represent the moments due to the rope in each of the several sections of the shaft. Thus, gk = 64,300 lb.-ft., kl = 6,820 lb.-ft., and la_1 = 1,290 lb.-ft. Let the vertical projection through c intersect the horizontal projection through k at the point m. Similarly, the vertical through d intersects the horizontal through l at the point n. Then the line $gmnb_1$ to the base a_1b_1 represents the variation of rope moment, on the assumption that the rope is coiled up at a uniform speed.

Now, during the starting period, the speed of the rope is uniformly increased from zero at the beginning to a maximum at the end of the period; and during the stopping period the speed is uniformly decreased to zero, as shown by the speed-time curve in Fig. 10 (a).

To correct the rope torque diagrams, Fig. 10(b), for the starting and stopping periods, in Fig. 10(a), starting from the point o, mark off the actual times for the ascending rope given in the table along the base ox. Thus, oc = 111·1 sec., cr = 20·9 sec., and rx = 12·3 sec. Make $ao' = ao$, then oo' is equal to the accelerating period—namely, 20 sec. Also, make $bx' = bx$, then $x'x$ is equal to the retarding period—namely, 28 sec.

Let the vertical projection from o' cut the rope-torque line gm, Fig. 10(b), in point p, then by joining o_1p we get the bent line o_1pm, which represents, to the base o_2x_2, the variation of rope moment for Section A of the shaft (Fig. 9).

In traversing Section B of the shaft the ideal time cd of 16·5 sec. corresponds to an actual time, cn, of 20·9 sec. Project r vertically downwards to intersect the horizontal projection through n at q. Let the vertical projection through x' intersect the ideal torque line mnb_1 at s. Join s and q and q and x_2. Then the effect of retardation is to bend the line from mnb_1 to $msqx_2$. Therefore the bent line o_1pmsqx_2, to the base o_2x_2, represents the variation of moment due to the ascending rope throughout the wind. Thus, t sec. after the commencement of the wind the ascending rope moment is represented by the line uv.

In like manner, the bent line o_2y, to the base o_2x_2, represents the moment due to the descending rope. The moment is uw after t secs.

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* The Electrician, August 16, 1918, p. 333.

* The Electrician, Aug. 23, 1918.

Hence, t sec. after the beginning of the wind the resultant rope moment is $uv - uw = wv$, and this moment is added in Fig. 10(c) to the torque due to the ascending and descending skips and friction, which, it will be remembered, is represented in this diagram by the stepped line $j\ .\ .\ .\ t$.

Other points are plotted in the same way, bearing in mind the reversal of sign of the rope torque near the middle of the wind, and the stepped sloping line $u\ .\ .\ .\ v$, Fig. 10(c) to the base ox represents the variation of static torque plus friction throughout the wind.

Acceleration and Retardation.

A drum speed of 45·5 revs. per min. is reached in 20 sec., therefore

$$\text{Angular acceleration} = \frac{45{\cdot}5}{60} \times 2\pi \div 20$$
$$= 0{\cdot}238 \text{ radian per sec. per sec.}$$

The hoist is brought to rest in 28 sec., and

$$\text{Angular retardation} = \frac{45{\cdot}5}{60} \times 2\pi \div 28$$
$$= 0{\cdot}17 \text{ radian per sec. per sec.}$$

The equivalent moments of inertia of the several moving parts are :—

Rotating parts—		
Motor, $1{,}238 \times 8^2$		79,300
Drums, clutches and gear wheel		145,000
Sheaves $(2 \times 8{,}000)(14 \div 16)^2$		12,200
Travelling parts—		
Nett load	10,000 lb.	
Two skips... ...	12,000 lb.	
Two ropes ...	30,500 lb.	
	$52{,}500 \times 7^2 \div 32{\cdot}2$	80,000
	Total	316,500

Hence,

$$\text{Accelerating moment} = 316{,}500 \times 0{\cdot}238$$
$$= 75{,}000 \text{ lb.-ft.}$$

and

$$\text{Retarding moment} = 316{,}500 \times 0{\cdot}17$$
$$= 53{,}800 \text{ lb.-ft.}$$

These two moments are added algebraically to the static torque diagram, Fig. 10(c), the line AB being for acceleration and JK for retardation.

The total torque diagram is represented by $oABC\ .\ .\ .\ HJKLo$ to the base ox. Having drawn this diagram, we can proceed to study the performance of the winder.

Throughout these articles we have endeavoured to emphasise the importance of the torque diagram. An engineer with whom the introductory series of articles was discussed expressed the opinion that the determination of the torque diagram was only touching the fringe of the problem ; but the author insists that the torque diagram is the core, and that it is to the study of winder propositions what the alphabet is to a language.

Motor Rating.—Allowing 95 per cent. for the efficiency of the gears, we get, when the torque is positive,

$$\text{H.P.} = \frac{\text{Torque} \times 2\pi \times \text{r.p.m.}}{33{,}000} \div 0{\cdot}95$$
$$= \tau \times 2\pi \times 45{\cdot}5 \div 33{,}000 \times 0{\cdot}95$$
$$= 0{\cdot}0091\tau$$

where τ is the torque in lb.-ft.units.

When the torque is negative

$$\text{H.P.} = \frac{\text{Torque} \times 2\pi \times \text{r.p.m.}}{33{,}000} \times 0{\cdot}95$$
$$= 0{\cdot}0082\tau$$

The torque values, given in Fig. 10(c), are converted into horse-power, and the power diagram is plotted in Fig 11. The ordinates of the power diagram when squared and plotted to a convenient scale give the cross-hatched diagram $oabcd\ .\ .\ .\ jkxo$, from which the rating is determined. This diagram has an area of

$$(2{,}070^2 + 2{,}020^2) \times 10{\cdot}4 \div 2 = 43{\cdot}50 \times 10^6 \quad . \quad (1)$$
$$(2{,}050^2 + 2{,}000^2) \times 9{\cdot}6 \div 2 = 39{\cdot}37 \times 10^6 \quad . \quad (2)$$
$$(1{,}320^2 + 1{,}240^2) \times 9{\cdot}2 \div 2 = 15{\cdot}09 \times 10^6 \quad . \quad (3)$$
$$\{1{,}130^2 + 186^2 + (1{,}130 \times 186)\} \times 81{\cdot}9 \div 3 = 41{\cdot}54 \times 10^6 \quad . \quad (4)$$
$$\{(-62)^2 + (-103)^2\} \times 4{\cdot}9 \div 2 = 0{\cdot}04 \times 10^6 \quad . \quad (5)$$
$$\{(-546)^2 + (-615)^2\} \times 15{\cdot}7 \div 2 = 5{\cdot}31 \times 10^6 \quad . \quad (6)$$
$$\{(-550)^2 + (-607)^2\} \times 12{\cdot}3 \div 2 = 4{\cdot}13 \times 10^6 \quad . \quad (7)$$

$$\text{Total area} \quad \ldots \quad 148{\cdot}98 \times 10^6 \ \frac{\text{H.P.}^2}{\text{secs.}}$$

The actual duration of the cycle—namely, 164 sec.—is equivalent to a full-speed value of 125 sec. Hence, rating of motor

$$\text{Virtual H.P.} = 1{,}000 \times \sqrt[2]{(148{\cdot}98 \div 125)}$$
$$= 1{,}090$$

We have now done what we set out to do, and the analysis can be completed by the reader at his leisure.

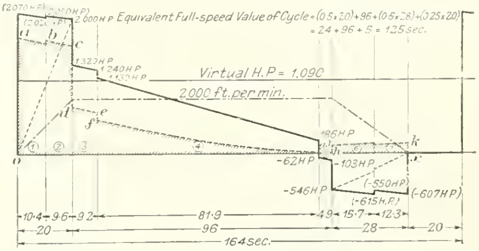

Fig. 11.—Power Diagrams.

In the preceding sections examples have been given of winders operating in shafts of uniform inclination and in shafts of varying inclination. The example of the latter, it will be remembered, was a shaft of which by far the greater part of its length was of uniform slope.

(*To be continued.*)

The Tungsten Industry.

In a recent issue of the "Journal" of the Society of Chemical Industry, Mr. J. F. L. VOGEL states that the consumption of tungsten is still essentially dependent on the demand for high-speed steel. The aggregate tonnage of tungsten consumed for lamp filaments, contact points, X-ray targets and as wires being very small, although it has increased materially since 1914.

Before the war the consumption of tungsten was about 4,000 tons per annum. During the war the output increased to 25,000 tons in 1918. It is mainly derived from the United States, South America, Portugal, Burma, Australia and China. At the time of the Armistice supplies of all concentrates were in excess of the current demand. There were large stocks of manufactured and scrap high-speed steel, the demand for which dropped to a minimum, so that the prices for all concentrates, tungsten powder, ferro tungsten and high-speed steel became nominal.

The war effected radical changes in the manufacture of tungsten and ferro-tungsten, and the standard British metal is now of a much higher quality than pre-war German output, so that an industry which had developed for 20 years in Germany has more than been equalled in efficiency and quality in two years by British firms working under war conditions. At the Armistice the British output capacity was almost in excess of the world's normal demands, and far in excess of the home requirements.

Once the stocks in hand had been consumed the normal consumption would settle down to something between war and pre-war rates, while the demand and supply would run more or less together from 1921 onwards. On this estimate, the ore supplies already in existence were likely to govern the market for a considerable period, but once stocks were absorbed or reduced to a low figure the costs of all concentrates were likely to rise from pre-war and current prices of 30s. per unit to something like 45s. to 50s., owing to costs of mining and exchange movements.

Water-Power and the Coal Problem.

By Capt. WM. I. TAYLOR, M.Inst.C.E.

Cheap power is certainly one of the basic factors enabling this country to compete favourably in the world's markets. We are told that the available water-power going to waste in Great Britain is close on 1,000,000 H.P., and that the cost for power derived from coal is on the increase, yet practically all our industries derive their power from coal.

Without doubt, the late war has helped to impress upon us the vital importance of water power. This is felt in our country even more than other manufacturing countries, for the reason that all industry is more or less dependent on coal. As things exist at present, it is incumbent that our energies be devoted more in the direction of water-power development and finding the means for coal conservation, both of which open up vast field for economies, though many radical changes are involved offering many difficulties. These changes must ultimately result, not only in widespread improvements to the public, but in the supply of cheaper power to every industry throughout the country.

It is estimated that the present annual consumption of coal for power purposes in Great Britain is around 80,000,000 tons, and that by proper centralisation of power generation and distribution an annual saving of nearly 70 per cent. can be made. At the same time, there would be the advantage of a reduction in the cost of transport and man-power, &c.

The Economies of Coal Conservation.

The following remarks on coal conservation go to show the vast field for economies from a purely engineering standpoint; but there exist other fields for economies aside from engineering, such as restriction upon the use of natural gas, curtailment of coal for the manufacture of certain articles, daylight saving, enforcement of "lightless" nights in certain districts, encouragement of peat-producing equipment and lignite-briquetting plants, restriction of illuminated advertising, &c., &c. Coal conservation may be still further extended so as to include the inefficient use of water-power plants. It may happen that the efficiency of a complete hydro-electric development is high, yet the efficiency in the utilisation of the water may be an entirely different matter, and show a great power waste, even though a mere 8 per cent. of our water-powers are developed, and little or no inter-connection of these plants is put into practice for securing the most economical use of the different watersheds and run-off, &c. We cannot at the present time look for much improvement in this direction; but our energies should certainly be directed toward a more general utilisation of water-power, even of those numerous small water-powers of from 50 H.P. to 200 H.P. in capacity.

In this country we are not so well favoured by Nature as Canada, California, Italy, Norway and many other parts of the industrial world with large water-powers capable of being developed at a low cost. In fact, comparatively speaking, we do not possess large water-powers capable of economic development. Of the former, the major part may be regarded as having greater economic value when used directly for manufacturing purposes, while the latter big water-powers, though somewhat remote from the existing power markets, may be more economically employed for supplying electrical energy to local electrochemical industries, to certain kinds of manufacturing and for municipal and public lighting, heating and pumping, &c.

The Basic Factors Discussed.

The two basic factors determining the amount of water-power are the hydrostatic head and the quantity of water which may be made to operate the turbines. The amount of power available at any particular site will depend mainly on the conditions of flow *i.e.*, the amount of power which is available for every day of the year. Usually it is possible to develop during the greater part of the year a considerably larger amount than this by impounding water due to flood and other flow conditions (greater than the minimum flow), and regulate the supply to suit the load curve. In estimating the amount of power that may be developed at any particular site, records of precipitation, temperature, run-off, &c., extending over a period of years, are required to be known with exactness.

Millions of pounds can be saved by closer attention to only a few of the after-mentioned problems, and at the same time we shall improve a thousandfold the technical value of engineers and workmen.

Construction *v.* Destruction.

During the last few years we have spent many hundreds of millions of pounds for destruction for preservation, and there is no reason why we should not during the next few years encourage the spending of a small percentage of this amount for construction and for improvements for conservation. Aside from purely engineering reasons, the work of developing the power resources of the country ought just now to be pushed with all possible energy by encouraging the development of water-power and the establishment of super-steam power plants economically located, and their interconnection to form a reliable and cheaper source of energy both for transportation and industries.

As regards transportation by rail, the transmission of electrical energy would more economically serve our needs: instead of hauling coal, the railways would be relieved of an enormous freight burden, thereby making available transportation for the hauling of other materials. Not only would the railways in the immediate district or county be relieved of hauling the coal for its own locomotives, &c., but other railways supplying them with coal would be relieved proportionally. This relief of strain on the rolling stock, the equipment and the railroad track would automatically result in an increase in transportation facilities and better use of labour could be made. Furthermore, through the inter-connection of electrical power plants by means of transmission lines, and by the operation of trains by electricity instead of by steam locomotives, a further increase of efficiency would be obtained, particularly in the economical central station, as compared with wasteful steam locomotives. Such a comprehensive system of power supply, making use, as it would, of undeveloped water-powers (tidal power and fresh water power), and of coal now wasted at the pits, would give a more continuous use of existing steam-power plants through the operation of the diversity factor—that is, the power for which there is no demand at a certain time in one locality could be transmitted to another locality requiring power; thus a large amount of spare plant capacity could be brought into service, and the money already invested in existing power plants would be more productive. Finally, the vast amount of labour required in the transportation and handling of this coal, as well as the mining of the coal, and in its conversion into power, would be saved and be released for better uses.

Conservation of Coal by Engineering Endeavour.

There are so many avenues open where a substantial saving of coal may be effected that it would be difficult to give a full explanation in several voluminous books. Some of the economies now in the writer's mind, and capable of being put into effect by the engineer, are:—

1. Better utilisation of electrical and mechanical power and improvement of the system power factor.
2. Enforcing the use of more efficient lamps.
3. Rearrangement of shafting and proper alignment of shafting in industries to reduce waste power.
4. Grouping of machines in a manner to flatten as much as possible the load curve.
5. Rearrangement of machines, apparatus and drives.
6. More general use of the electric motor.

7. Stopping of motors and machines when running idle to reduce power waste.

8. Proper adjustment of motors and machines and apparatus to reduce power lost.

9. Systematic testing of machinery and apparatus, &c., with a view of saving power.

10. Reduction of unnecessary steam pipe lines.

11. Proper insulation of steam pipes.

12. Possibility of extracting byproducts, &c., before consuming coal for power purposes.

13. Possibility of using the coal at present left in the pits or thrown on the dumps and wasted.

14. Restriction of electric generating plants in factories, hotels, office and apartment buildings, hospitals, &c., where supply can be had from central stations.

15. Substitution of electric power in steam-driven pumping plants.

16. Effort be made to standardise, so as to avoid complexity and inefficiency (for instance, in London and districts, there are 10 different frequencies and 24 different distribution voltages).

17. More attention should be given to the development of power from coal at the pit mouth, particularly in those cases where it does not pay to mine and transport certain grades of coal.

18. Every effort should be made for refuse burning to generate power.

19. Encouragement of railway electrification, and the saving of power effected by utilising the weights of trains running down grade to generate electricity which is returned to the system.

20. Staggering the hours of operation and stopping of industries, &c., as a means of smoothing out the load curve. A comparatively small change in closing hours of 30 minutes may result in a large saving in generating capacity.

21. Concentrated effect to secure higher efficiency, not only of the units (machinery and apparatus) of power generating stations, but of the system of which the units are an integral part.

22. Creation of super-power stations suitably situated with respect to cheap and reliable supplies of coal. If located economically, it may mean that the saving in railway transportation will be more than enough to pay for the cost of transmission lines, and the gain is not only a saving in coal and transportation of the coal, but also a saving in man-power and a direct aid to the surrounding sources and industries.

23. Interconnection and co-ordination of power plants and systems to form one comprehensive unit.

24. Remodelling of old systems and the installation of new systems to ensure that their designs are adopted to facilitate the many advantages and economical benefits of parallel operation with other systems.

25. Study of the various company load factors, equipments and requirements, with a view of instituting a master load-dispatcher to handle the load in the most efficient manner. When operating in parallel with hydro-electric plants, use could be made of considerable water-power otherwise going to waste.

26. Interconnection of power systems, both steam and hydro-electric. As no company operates at 100 per cent all the time, and as the peak loads are different for the different companies, better use can be made of the maximum water-power, and also an increase made in the average load factor.

27. Closing down of uneconomical central stations where in the same territory a more efficient power plant is able to give the service.

28. Where possible, better use made of transformers that are too small and too numerous, and that operate most of the time on light loads and are left in circuit 24 hours of the day.

29. Where possible, better use made of duplicate cable lines and transmission lines serving practically the same territory by tying them in parallel or cutting them out of service.

30. Closer study into such questions as the load factors of units and of systems, diversity factors, &c.

31. Closer investigation and research, with a view of increasing the efficiency of modern steam power units and the more useful heat value of coal.

32. Increased utilisation of water-power, with and without storage of water.

33. Economical operation of water turbines and increased over-all efficiency of plant.

34. Water economy in hydro-electric plants.

35. More efficient planning of flashboard work and reduction in leakage and overflow.

36. Better maintenance of a higher forebay level and more careful estimating of the river flow and load.

37. Improvements in operating methods.

38. More economical loading of main units, economies of station auxiliaries, closer co-operation with the steam plant operators, and more rapid restoration of service and better synchronising of maintenance work, &c., &c.

39. Utilisation of tidal power.

The International Electrotechnical Commission.

Meetings of the Advisory Committee of the International Electrotechnical Commission were held in Brussels from March 27th to 31st, and we have received from the general secretary an official account of the proceedings. About 35 delegates were present from eight different countries. Those representing Great Britain were Major K. Edgcumbe, Mr. A. R. Everest, Mr. A. J. Stubbs, Mr. C. Rodgers, Mr. W. B. Woodhouse, Mr. C. H. Wordingham and Mr. C. C. Walton. Before business commenced visits were paid to the Yser battlefields and to the devastated areas round Courtrai, Nieuport, Dixmude and Ypres.

Rating.

The first volume of the I.E.C. Rating Rules for Electrical Machinery for machines not exceeding 5,000 volts, 750 k.v.a. rated output and 50 cm. in length axially, had been previously approved for issue; this meeting, therefore, devoted most of its time to consideration of questions which would apply to larger machines.

In regard to high-voltage tests, it was agreed to recommend to the National Committees that the dielectric tests given for the smaller machines in Vol. I. of the I.E.C. Rules should apply also to large machines, with the exception of turbo-alternators. In regard to the latter the French Committee's proposals that the high voltage tests on turbo-alternators and similar machines should be increased, have been referred to the National Committees for consideration. The use of embedded temperature detectors for the acceptance tests of electrical machinery was again discussed, and whilst it was generally agreed that these should be used in the case of large machines, there is still a very considerable difference of opinion as to the limit above which the use of this method of measurement should be compulsory, and the question will need further consideration. The American Committee recommend the use of embedded temperature detectors for all rotating machines larger than those dealt with in Vol. I. of the I.E.C. Rules, whereas the British Committee propose their compulsory use for acceptance tests only for (1) turbo-generators and similar machines over 5,000 k.v.a., whatever the voltage and core-length; (2) other rotating machines over 90 cm. core-length, whatever the kilovolt-ampere and voltage or over 65 cm. core-length, if over 6,000 volts whatever the kilovolt-ampere.

In regard to the terminal markings given in Appendix I of the I.E.C. Rules, it has not been agreed to recommend these for adoption, as the American Committee have pointed out that it is undesirable to fix terminal markings for transformers until terminal markings for motor and control apparatus have been settled; the American Committee has been invited to forward a specific recommendation on this point.

Graphical Symbols.

The British delegates submitted the British list of graphical symbols prepared, but not yet issued. This British list had been based on the proposals received from the Italian National Committee, the B.E.A.M.A., and many other sources, and it is gratifying to record that many of them have been adopted for recommendation to the National Committees for acceptance internationally.

Nomenclature.

The work on nomenclature which has been suspended during the war was recommenced. The general principles upon which the work should be developed were discussed, and it was decided to prepare an international electrotechnical vocabulary taking into consideration all the existing national vocabularies. Each National Committee is to add a translation of the definitions in its own language in a national edition. The vocabulary is to be compiled so as to include a definition of the word in English and French, and in such a way that there will be no difficulty in finding, either in the vocabulary or in an appendix, the equivalent words in the various other languages. With regard to the question of adding translations of other languages it was felt that it would not be possible in the official publications to extend beyond the official languages of the I.E.C., namely, English and French. In order to hasten the work, a Sub-committee was appointed, a meeting of which will be held at Zurich some time in June.

The following recommendation proposed by M. Paul Janet was accepted for reference to the National Committees: In view of the fact that (*a*) It is of the greatest importance to unify the electrotechnical nomenclature and symbols in every country; (*b*) it is equally of the greatest importance that new electrotechnical terms, definitions and symbols should be formulated from the point of view of international usage; (*c*) there is a more or less widespread tendency towards the adoption, in various cases, of electrotechnical terms, definitions and symbols which too often do not anticipate nor lend themselves to international use the Advisory Committees on Nomenclature and Symbols feel that it is very desirable that the National Committees should exercise in their respective countries a moral influence to prevent or to stop the formulation of electrotechnical terms, definitions and symbols which would ultimately present a serious obstacle to international agreement.

Standard Pressures.

The Advisory Committee on Standard Pressures for Insulators considered various proposals which had been submitted by the National Committees, and finally formulated a series of standard high pressures, together with the proposals for the high-pressure test in each case. These proposals will be submitted to the various National Committees for their consideration.

The Development of Electric Baling Presses.

Owing to the scarcity of shipping facilities and the high cost of freight, it is of the utmost importance that all goods which lend themselves to such treatment without damage, should be tightly packed in order to increase the density of the bale and to reduce the space occupied per ton. The same argument applies equally to both raw materials, such as cotton, wool, hides, &c., and to finished products, such as cloth piece goods. In the case of home trade, the advantage of a tightly packed bale, with consequent greater resistance to rough usage, is also evident, in addition to the saving due to the decreased amount of canvas covering per bale when the latter is compressed.

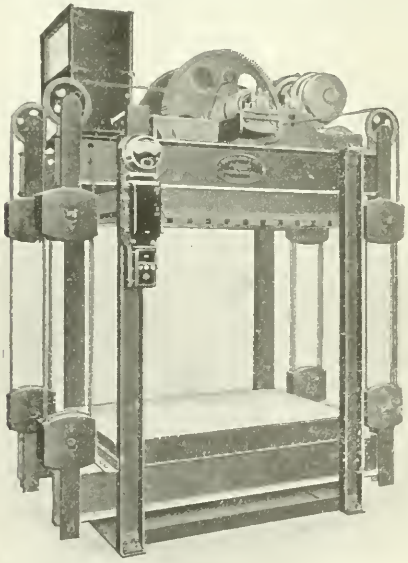

Fig. 1.—25-ton Open-type Electric Press.

Until the appearance of electric baling presses a few years ago, no machine had been evolved which was capable of producing the pressure requisite for the packing trades and pressing industries, other than those machines which were operated hydraulically and were often inconvenient for that reason. It is almost obvious to remark that all levers, toggles, screws and other complicated means of obtaining mechanical purchase have been discarded in the design of the electrical press constructed by Messrs. Hindle & Company, of Haslingden, on account of their inefficiency or because of other disadvantages. In their place is used a simple pulley-block system, with specially flexible steel wire ropes, at each corner of the table. The tail rope from each corner is wound on two or more parallel and grooved winding drums, which are operated by means of high-efficiency reduction gearing from the motor. By adopting suitable sizes of winding drums, the travel can be increased indefinitely, which is impracticable with any system of levers. The use of the parallel winding drums also allows, it is claimed, the full pressure to be exerted at any position in the travel of the table, almost essential property where bales of varying materials and dimensions have to be dealt with.

On consideration it will be evident that when compressing resilient material, the pressure required for a considerable portion of the travel is comparatively small, but that this pressure increases very rapidly towards the end of the compression. The advantage of the electric motor, as applied to this class of work, is that current is drawn from the supply mains in approximate proportion to the work being performed at any instant. The current taken, therefore, is at first very small, gradually increasing to a maximum, when the press is stopped automatically (*see* Fig. 2). A further important advantage is obtained by the use of a plain series-wound motor, whose speed is automatically reduced as the pressure extered increases to the maximum, thus corresponding with the minimum motor speed and the maximum current consumption.

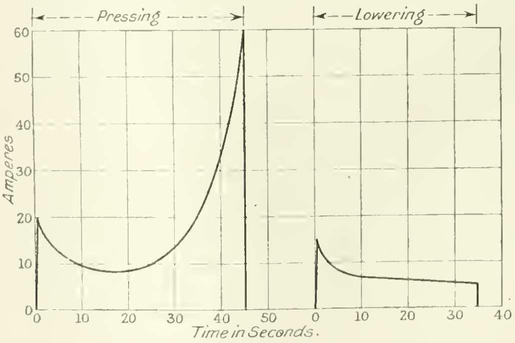

Fig. 2.—Load Diagram of an Electrically-Driven Baling Press.

The motor used on Messrs. Hindles' press is specially designed and constructed to operate at a high speed on light loads, and is provided with ball or roller bearings to reduce the friction losses as low as possible. The armature is exceptionally well banded and carefully balanced. By these methods the increase of speed from maximum load to minimum load may be easily br 500 per cent., or even more. Being positively geared to the winding drums, the motor only revolves, in either direction as required, when the press table is actually moving up or down.

The illustrations show the general mechanical construction of the machine. Fig. 1 is a view of a press to develop a maximum pressure of 25 tons. This press is fitted with a series motor capable of a peak output of 4 B.H.P. at 400 revs. per min., and which speeds up to about 2,000 revs. per min. on light loads or when running down. Machine-cut double-reduction spur gearing is employed between the motor and winding drums, the motor pinion being of raw hide or paper. The rated speed of travel at the instant the full pressure is exerted is 18 in. per minute, increasing to about 90 in. per minute on light loads. The average speed of the table is about 70 in. per minute, but varies slightly according to the kind of material being compressed. The tables measure 5 ft. long by 3 ft. wide, the daylight is 4 ft., and the maximum travel about 3 ft. Push-button control is fitted, with "Up," "Down," and "Stop" buttons electrically interlocked, operating contactor switches in the controller box mounted on the press. An auxiliary current limit-switch prevents accidental overwinding by stopping the motor when the table reaches the highest and lowest points of travel respectively.

When full pressure is attained, irrespective of the size of bale under compression, the motor is stopped by a maximum current relay in the controller box. In this manner, the control is, it is claimed, absolutely mistake-proof, and these features enable unskilled labour to be readily employed, and are obviously very easily combined, owing to the purely electrical system of control of which they are inherent.

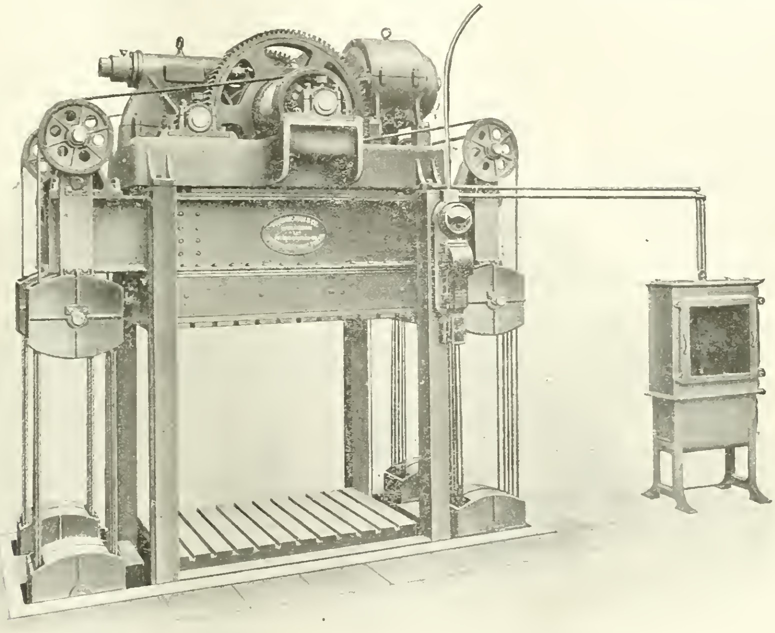

Fig. 3.—200-ton Open-type Electric Press.

With this machine about 100 bales can be made for one Board of Trade unit. Electric presses of this size are very extensively employed for home-trade baling, a number having been used at Ministry of Munitions Depots for baling aeroplane fabric during the recent war.

Owing to the high efficiency of the hoisting mechanism, provision has to be made to prevent the table lowering underload, due to the resilience of the compressed bale, after current is cut off. Owing to the rapid action, it is likewise necessary that the moving parts should be quickly brought to rest when stopping. Both these objects are attained by the adoption of an automatic brake, incorporated in the motor itself. The details of this brake are as follows: the circular endplate of the motor is formed into an annular, iron-clad magnet with an energising coil through the centre of which the shaft protrudes. This magnet attracts a cast-iron brake disc, which is supported on four studs from the frame of the motor, and is faced on the opposite side with asbestos brake lining. A compression spring on each stud forces the brake-disc lining into contact with the revolving pulley or disc, which is mounted on a feather key on the end of the shaft, and which can be moved along the shaft by means of a large circular nut so that the air-gap of the magnet may be adjusted to compensate for any wear of the brake lining. The nut is locked in position by the two setscrews shown passing through the nut into the brake pulley. While the brake is released by the magnet when the motor is running, no end thrust is caused, but immediately the brake is applied by the springs on interrupting the coil circuit, end thrust comes into play, and is taken up by the ball or roller bearing in the magnet endplate. The dimensions of the friction surfaces are suitably chosen to keep the thrust within reasonable limits. This novel arrangement of electromagnet brake is, we are informed, very positive and reliable in operation, there being only one moving part, the distance moved being 1/32 in. to 1/16 in., according to size.

An electric press of larger size recently shipped to the South Indian Export Company, Bombay, for baling hides and skins for export, is shown in Fig. 3. The general principle is identical with that of the smaller press, with the parts proportionately stronger to withstand the stresses imposed by the pressure developed, which is nominally 200 tons. The motor is series wound and is capable of a peak output of 30 B.H.P. at 230 revs. per min., increasing to about 1,200 revs. per min. The tables of this press are 6 ft. by 4 ft., and the clear daylight, or height between the tables, is 5 ft. The maximum travel is 3 ft. 6 in. In this case high-efficiency worm-gearing is employed for the primary reduction, and the contactor control gear arranged separately as shown in the illustration. On test the time taken to compress a bale of jute bags measuring 5 ft. free to 2 ft. in height was 45 seconds. Lowering out occupied 35 seconds. The maximum current on a 440-volt circuit (direct current) was 60 amperes, the current consumed being about one-eighth unit per bale, *i.e.*, eight bales per Board of Trade unit. The current demand during the compression of the bale and lowering off is shown in the diagram, Fig. 2, which indicates very clearly the momentary peak load when exerting full pressure and the close approximation of the current curve to the theoretical shape of curve due to the resistance of material to compression.

We are indebted to Messrs. Hindle & Company for the blocks illustrating this article.

Wireless Telephony on Aeroplanes.*

By Major C. E. PRINCE, O.B.E.

The summer of 1915 is believed to be the first occasion when wireless speech was received from an aeroplane. In spite of this success the difficulties in producing good articulation and a light and practical set were great, but they were gradually surmounted.

At that period the soft valve was in use, with a lime-coated platinum filament. The handling of this by unskilled persons was one of the greatest difficulties. Otherwise purely electrical difficulties have throughout been less serious than the telephonic, practical, and mechanical ones.

At first only transmission from air to ground was attempted. The first practical set evolved was a transmitter, capable of employing either speech, continuous wave, or interrupted continuous wave ("tonic train") as shown in Fig. 1. This was essentially a self-contained oscillating system, to which the aerial was loosely coupled. The microphone was inserted in the earth-lead, and modulated the radiation by varying the resistance of the aerial. The set was provided with three meters, A showing the aerial, *a* the filament, and MA the high-tension feed currents. The plug (P) served to bring into action either the microphone (M), buzzer (B), or to complete the circuit of the artificial aerial (AA). If not plugged in, the set worked as a plain continuous-wave transmitter. High-tension current was supplied at 600 volts from a dry battery of small cells, weighing about 36 lb. The microphone was suspended on rubber in a frame held in the hand. Some of the best ground microphones proved useless in the air, and the choice finally rested on an old-type Hunnings Cone. It is almost impossible to predict from its behaviour on the ground whether any particular microphone or type of microphone will work well in an aeroplane. The set weighed, without batteries, 10 lb. It was used on a trailing aerial 250 ft. long and employed a wave-length of approximately 300 metres. The radiation was very good, on one occasion spoken messages being picked up and recorded at a distance of over 100 miles, although the aerial current in the transmitting aerial was less than 0·25 ampere. The ordinary working limit of range from air to ground was about 20 miles for telephony, 30 to 35 for tonic train, and about double this distance for pure continuous-wave. At this time it appeared best to transmit to the air by Morse only, and the author made up a valve receiver with one soft valve. In 1916 ranges of from 30 to 50 miles were obtained from a ¼ kw. spark set, but the adjustments proved rather difficult for unskilled personnel.

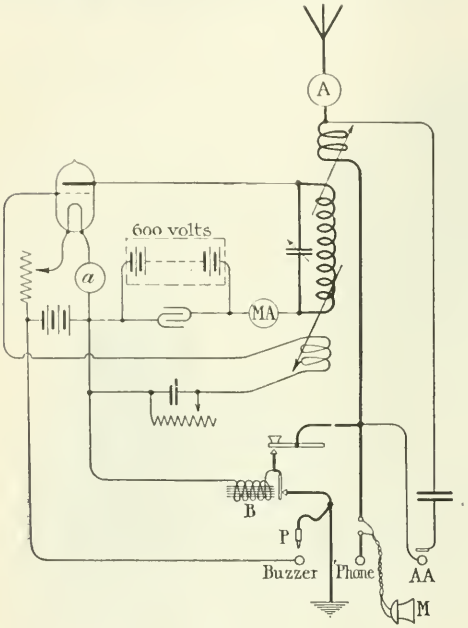

Fig. 1.

Inter-Machine Communication.

The Overseas Forces did not for a long time make any use of air-to-ground telephony, although just before the Armistice its introduction for reconnaissance and similar work, as originally suggested in 1915, was recommended. An urgent demand arose, however, for telephonic communication between machines in the air. The necessity for using apparatus suitable for use by unskilled personnel, or by those with very slight training, favoured telephony as against telegraphy.

Easy working implied difficult designing, which was, however, simplified by the introduction of a reliable, small, hard transmitting valve of French type, capable of handling about 20 watts, and similar valves with slightly more open grid for use in reception. In the transmitting apparatus an ordinary reaction or regenerative circuit provided the radio power.

In every known method of modulation variations of intensity or output are accompanied by some change of wave-length. The receiver can be adapted to take advantage of one or the other factor, so that any type of transmission should be considered in relation to its inception. Thus a receiver in which reaction is relied on, with a very steep and peaky resonance curve, is peculiarly sensitive to wave-length changes; whereas the modern type of flatly tuned high-frequency amplification receiver takes no account of this, but responds alone to changes of amplitude or intensity. In any system in which the change of wave-length preponderates, good or bad articulation can be produced on a reaction receiver according to the slope of the resonance curve on which the adjustment is made. A slight change of wave-length will produce enormous variations of intensity in the receiver, but there is considerable distortion of speech quality, since the true proportionality is lost.

Method of Control.

No method of controlling the radiation directly by the microphone proved satisfactory, and the choice fell on some form of indirect control. In the final arrangement, the "choke" control, the modulation is applied to the anode circuit of the control valve.

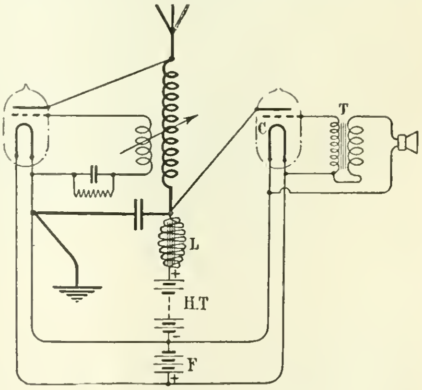

Fig. 2.

Suppose that in the anode feed circuit of a simple valve oscillator is placed the secondary winding of an ordinary step-up transformer, the primary of which is a microphone and battery circuit. Variations produced by the voice will give rise to changes of the potential "control" valve whose grid is acted on by the original microphone in the anode feed circuit. For magnifying this effect we introduce a transformer, whose anode is in series with a one-to-one transformer in place of the original one. If the two valves are comparable and supplied with similar high tension, we can apply a modulation or variation of the same order as the energy dealt with by the first or "power" valve. The control valve can be supplied from the same source of high tension as the power valve; the transformer becomes a choke coil, and the filaments and microphone primary circuit may be worked off the same low-tension battery.

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*Abstract of a Paper read before the Institution of Electrical Engineers.

The circuit now becomes as shown in Fig. 2 in which P is the power and C the control valve, L is the choke coil, and T the microphone transformer. H T is the source of high-tension supply, and F is the filament battery. When variations take place in the control-valve anode circuit at speech frequency, large surges are set up in that of the power valve, which may approximate to the original high-tension direct current potential and so sweep the output from nearly double its steady value to almost zero.

Choke control proved eminently suitable for air working. There are no critical adjustments anywhere, and almost every constant can be changed within wide limits. For a sound frequency of 750 per second an inductance of not less than 5 henries is required; after that, the curve flattens out, and almost any higher value is immaterial. Resistance, however, is always detrimental. The little 20-watt choke control set, outlined above, became the standard R.A.F. set with which all the air transmission has, up to the present, been done.

THE USE OF REMOTE CONTROL.

As regards the general lay-out of the set (Fig. 3), the use of "remote control" was an important feature. The set could be mounted at a distance in any convenient position, and only a very small control unit for operating it was brought within reach of the user's hand. In the transmitter no adjustments were necessary, as a fixed wavelength, a definite aerial, and fixed reaction were used, so that the control unit carried only a switch, an aerial ammeter, and plugs for microphone receiver. The aerial ammeter was merely an indicator that all was well. The switch made or broke the dynamo field, filament and microphone circuits, so that when it was off every circuit was dead.

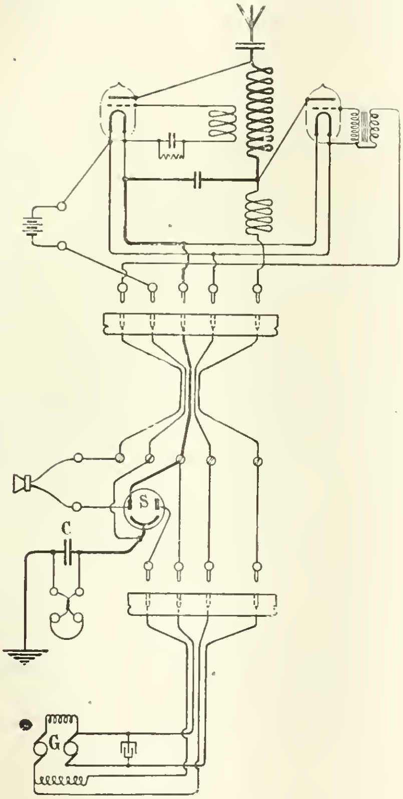


FIG. 3.

Remote control also tended to mental directness. It was necessary merely to switch on and talk. Although the first telephone had been supplied with high-tension current from dry cells, these had been completely superseded by small air-driven generators. The standard generator adopted gave about 600 volts from one commutator at its normal speed of 4,000 r.p.m., while the 6-volt filament accumulators were floating across the low-tension side. Moderately good electrical regulation was provided by a demagnetising field winding system.

We come next to the microphone proper. The disturbing elements are: (1) mechanical, and (2) acoustical. The former include the shaking up of the carbon granules by movements of their container, and slow distortions of the diaphragm under varying air-pressures. Neither is serious, and the first-named is almost completely eliminated by holding the microphone in the hand—the finest possible shock absorber. The acoustical difficulties are far worse, because the noises which it is desirable to reject are of the same order as the sounds that are to be accepted. Eventually microphone was designed almost insensitive to sounds of the noise intensity, but responsive to the powerful concentrated sound waves of a voice impinging upon it from a very short distance. By choosing a suitable thickness of diaphragm, size of granule, tightness of packing, &c., combined with heavy damping, a satisfactory microphone was arrived at. It was curiously ineffective on the ground, but took on a new sprightliness in the air.

The problem in receiving was to combine considerable sensitiveness, loud signals free from distortion, and minimum of adjustment. It was only lately that high-frequency magnification became sufficiently manageable for introduction into aircraft, and low frequency could not be pushed far without making a set far too sensitive to mechanical shocks. The surviving arrangement consisted of a detector valve with reaction, and two note magnifications. The detector valve was not energised direct from the aerial, but through an "aperiodic" circuit, *i.e.*, one approximately syntonised by its self-capacity, which reduces magneto noise considerably.

The application of remote control to the receiver really antedates its adoption on the transmitter. The principle involved is, that the increase in emission caused by brightening the filament of the detector valve, whose anode current is concerned in the reaction, steepens the characteristic curve and so determines the oscillatory condition, when the circuits have been adjusted near the critical point; a condition which can easily be provided for in the design. The adoption of this principle had a large share in the success of the aircraft telephone.

H.F. MAGNIFICATION.

Prior to the war high-frequency magnification by resonance methods had been in use, and attempts were made to effect it by simple means, aperiodically if possible, in which the French experts had taken a leading part. Capt. Round eventually unified and correlated the various circuits, showing how all such transformers could be considered to be essentially resonance transformers, differing only in damping. Special low-capacity valves were introduced with maximum damping, and high-frequency magnification was tamed and harnessed.

The first fruit of this advance was a five-valve receiver, which was, as compared with the former three-valve receiver, about 10 times as sensitive for strong signals, and 30 times for weak ones.

Since the new type of receiver had not come into general use up to the time of the Armistice, all actual work was done with the three-valve receiver and transmitter already described. Trailing aerial wires of 120 ft. length were used in the transmitting machines, with an aerial current of about 0·4 ampere, while the receiving machines had aerials of from 80 ft. to 100 ft. in length. The normal safe working range from machine to machine was about 4 miles, while the range to a ground station was from 20 to 50 miles or more.

Wireless telephony also assumed great importance for home defence against air raids; and a chain of ground stations of considerable power was put up capable of transmitting up to about 100 miles to a machine in the air, in order to warn the patrols of the approach of an enemy.

After the signing of the Armistice the Cologne postal service was equipped, both ground and air, entirely with the little aircraft sets, and some remarkable results were obtained. The ground stations, which had 70 ft. masts, were set at 50 miles apart, and could transmit 30 miles to a machine, or receive from a machine at a distance of about 50 miles.

The International Convention has specified as the maximum allowable an input of 100 watts for the transmitter. Choke control will be retained. All types of transmission will be provided for. The receiver will have three high-frequency magnifications and one low, making with the detector five valves, and the combined transmitter and receiver will be worked from one remote control. Batteries will be retained at present for filament lighting, but in the near future a perfectly silenced and regulated generator may permit of the abolition of the battery.

Ground stations will be equipped for direction-finding with a transmitting mast one or two hundred yards away controlled from the receiving building, and matters will probably be so arranged that the ordinary P.O. land lines can be plugged direct on to the wireless, so that a man may talk direct from his office to a machine in the air.

Electricity Supply Tariffs.

A discussion on the above subject took place at a recent meeting of the North-Western Centre of the Institution of Electrical Engineers.

The discussion was opened by Mr. S. J. Watson, who, in his introductory remarks, pointed out that the principal items of expense in supplying electrical energy were as follows:—

(1) Power station, including (*a*) annual charges for capital employed, (*b*) wages, (*c*) management, (*d*) rates and (*e*) materials including fuel. (2) Transmission, including (*a*) capital charges, (*b*) maintenance and (*c*) losses. (3) Transformation and or conversion (*a*) capital charges, (*b*) attendance, (*c*) maintenance and (*d*) losses. (4) Distribution (*a*) capital charges, (*b*) maintenance and (*c*) losses. (5) Metering and accounting.

The only item independent either of the rate at which a supply is taken or of the actual number of units supplied, was that of metering and accounting, which only represented a small proportion of the total costs, but was of some importance. The expenditure per annum on most of the other items was unaffected by the number of units actually supplied, but was fixed by the rate at which the supply was used.

The costs at the power station might, therefore, be resolved into two parts—namely, the standing costs, amounting to £x per annum per kilowatt of maximum demand, and a running cost equal to y pence per unit sent out. As an example, Mr. Watson assumed £5 per kilowatt per annum of maximum demand and a running cost of 0·40d. per unit supplied, based on fuel at 32s. 6d. per ton, and discussed the influence of the load factor and diversity factor. The product of load factor multiplied by the diversity factor could not exceed 100; but a 100 per cent. load factor at the power station would be equally attained whether a number of consumers have a load factor of 1 per cent. with a diversity of 100 or a load factor of 100 per cent. with a diversity of 1. The standing portion of the cost at the power station might, therefore, be fully secured by a charge varying between the very wide limits of, say, £5 per kilowatt of maximum demand per annum for consumers having a load factor of 100 per cent. and a diversity of 1 or of 1s. per kilowatt of maximum demand per annum for consumers having a load factor of 1 per cent. and a diversity of 100 the cost per unit supplied remaining unaltered.

For the standing portion of the costs per kilowatt per annum of the rated capacity of the transmission, transformation or conversion and distribution systems, a figure of £3 per annum was assumed to cover the provision of such equipment and the constant losses, attendance and maintenance. Here, again, the standing portion of the costs incurred on transmission, &c., might be met by a charge which may vary between the limits of £3 per kilowatt of maximum demand per annum for consumers having a load factor of 100 per cent. with a diversity of 1 or of 7·2d. per kilowatt of maximum demand per annum for consumers having a load factor of 1 per cent. and a diversity of 100. The original running cost of, say, 0·40d. per unit would require some addition to compensate for that portion of the losses in transmission, &c., which varies with the units consumed. Strictly, however, transmission, transformation or conversion and distribution should be considered under three separate headings.

The Question of Tariffs.

In considering tariffs it was convenient to discriminate between large bulk supplies or supplies to large industrial concerns and detail distribution. For the former class of supply only two types of tariff had been generally in use—namely, (1) a compound charge of £x per annum per kilowatt demand *plus* a charge of y pence for each unit used; and (2) a flat rate roughly equal to the average price per unit which the compound charge was expected to yield, assuming a certain load factor; provision being made in both cases for a variation in the charge per unit for any change in the price paid per ton for fuel from a fixed standard. It was, however, difficult to ensure that any particular load factor would be reached and maintained. Hence, the compound charge method was becoming the standard practice, though there were considerable differences in the method of applying this form of tariff. In framing a compound tariff, the running charge should as closely as possible be based on the cost for fuel and losses incurred by each unit transmitted, transformed or converted and distributed. The general adoption of a 47 or 48 hour working week instead of 54 to 56 hours had reduced the load factor from about 31·5 per cent. to 27 per cent., and, as the diversity of this particular class of load rarely reached 1·2, the resultant usage of the whole equipment had been reduced from 37·8 per cent. to 32·4 per cent. Clearly such a change would materially affect the results of a rate fixed on the above basis. One of the first engineers to recognise the necessity of introducing a compound tariff for consumers requiring a supply for several hours a day was the late Dr. John Hopkinson. In his presidential address to the Junior Engineering Society on December 4, 1892, he analysed the capital expenditure and working expenses of a typical lighting station of that period. The annual expenses were divided into two parts—*i.e.*, (1) those independent of the hours during which the supply is used, and (2) those directly proportional to the actual units supplied. The final result obtained was that "it will cost those giving the supply not much less than £11 per annum for every kilowatt—that is, for every unit per hour which the consumer can take if he wishes and afterwards to actually give the supply will not cost very much more than $\frac{1}{3}$d. per unit" (with coal at 20s. per ton). Dr. Hopkinson recognised that the application of his method to certain classes of consumers would bring the average charge per unit to a higher amount than allowed under the Acts. He therefore proposed that it should be applied as an alternative to the existing flat rate. The principles adopted by Hopkinson in dividing up the costs had withstood the test of time, and, with slight variations, were accepted to-day.

Attempts had, however, been made to employ other tariffs which might be expected to yield approximately the same results.

Charging for Power Supply.

In connection with motor power, for instance, the following forms of tariffs were in use:—

1. A sliding scale of charges from, say, 3d. per unit down to 1d., based on the number of units used per horse-power per quarter or year.
2. Several flat rates starting at about 3d. per unit down to a $\frac{1}{2}$d., based solely on the number of units used.
3. The maximum demand system introduced by Mr. Arthur Wright at Brighton in 1893 provides that a comparatively high price is charged, say, of 3d. to 4d. per unit for the use of the maximum demand a certain number of hours per annum, and a much lower price, say from $\frac{1}{2}$d. to 1d. per unit, for all additional consumption. In some cases an intermediate rate is charged for the units corresponding to the use of the maximum demand for a certain number of additional hours before the lowest rate is reached.
4. Several flat rates per unit depending on the purpose for which the supply is used; for instance, cranes, lifts and hoists, 3d. per unit; motors used intermittently in workshops, 2d. per unit; motors used continuously during ordinary factory hours, 1d. per unit.

With the exception of the sliding scale based on quantity, all of these tariffs gave results somewhat similar to those obtained by the Hopkinson method, and there were now very few cases where one flat rate per unit was charged for power without any variation due to load factor or quantity.

For ordinary lighting purposes, various tariffs were more or less akin to the Hopkinson method. With the maximum demand system, the primary charge was 6d. or 7d. per unit, with a secondary charge of 1d. to 3d. per unit. Where several flat rates were charged, these might be 7d. per unit for short-hour users, such as office, warehouses, schools, &c., 6d. per unit for shops and 5d. per unit for long hour users, such as places of amusement, hotels, public houses and basements. Concessions were sometimes made in the form of discount off a fixed flat rate, varying with the number of hours the supply was used or on the quantity taken. For lighting only, the income derived from houses rated at £20 to £40 a year, which largely predominated in industrial areas, would not exceed an average of £3 to £6 per house per annum, an amount inadequate to cover the costs incurred. Special tariffs had, therefore, been devised with a view of increasing the revenue per house by encouraging the use of the supply for purposes other than lighting—*e.g.*, domestic power, heating and cooking. The object sought to be obtained by such tariffs was that (1) it should yield an income per house bearing a close approximation to the costs incurred; (2) it should be easily understood by consumers; (3) only one system of wiring should be required with one meter; (4) it should induce consumers to use the supply for all possible purposes; (5) it should encourage the consumer to wire for the maximum points of usage.

Standing Charge plus Charge per Unit.

Various tariffs involved a fixed standing charge per annum and a low charge for each unit supplied; but such methods possessed disadvantages, because there was a marked difference in the habits and in the conditions of usage between those occupying a large and a small house. The standing portion of the charge per annum was obtained in an arbitrary fashion, without regard to the value of the actual services rendered. The costs did not depend in any real sense on an assumed demand, the rateable value or the number of rooms;

yet some of these systems had proved effective in practice, and resulted in a large increase in consumption and revenue. Much less care and concern was shown in using the supply if a consumer realises that only ½d. or 1d. per unit had to be paid after the standing charge is met, and additional consumption was thereby assured.

The strict application of the Hopkinson differential charge or of the maximum demand system was unworkable for domestic purposes, mainly because consumers could not understand why the amount payable as a standing charge should vary quarter by quarter or year by year. He therefore supported the necessity of some form of tariff ensuring a standing charge per annum plus a low running charge per unit. In connection with domestic tariffs, one other system—namely, a fixed annual charge per lamp installed, without any charge per unit used—had the undoubted advantage of simplicity when applied, say, to small cottages or workmen's dwellings; but was apt to lead to a wasteful use of the supply, and it could not conveniently be adopted when heating or cooking appliances were installed.

An immense amount of good would result if an effort was made to standardise methods, so that some, at least, of the many anomalies which existed in the charges of adjacent undertakings might disappear in the future.

A Short Discussion.

In the subsequent discussion, Mr. J. Frith agreed that the mixed tariff did not take account of the effect of the different times at which the maximum loads of consumers came on. He also endorsed the need for an easily understood tariff and for uniformity in adjacent areas. The outlooks of a private electrical supply company and a municipality were essentially different. The domestic tariff with a fixed charge per annum did substantial justice and worked well in practice. Mr. W. J. H. Wood also referred to the need for uniformity, and approved of a fixed charge plus a fixed charge per unit. It was a mistake to adopt two distinct rates, a power rate and a basic rate. Mr. S. L. Pearce said that the uniform charge was now out of the question. Correct systems must be based upon proved costs, and not influenced by methods prevailing in quite a different district. The value of the diversity factor given by Mr. Watson (1·2) was low; in his own district it was about 2·2. He feared that in existing conditions it was impracticable to expect uniformity of charges; but it might be possible to have a uniform charge for bulk supplies. Mr. Romero considered that the Hopkinson system in a modified form could be advantageously applied to lighting. He took a hopeful view of the future of electric heating. Mr. W. Fennell argued that the scientific basis of determining rates had been overdone. Practice should resemble more closely that in other industries. The Chairman said that in practice the Hopkinson system had to be altered to meet the needs of individual consumers; but a variation of it was essential for bulk supply. The time had come for wholesale scrapping of some of the earlier regulations affecting the supply of electricity. Mr. Drummond Paton suggested that the Corporation might aid the small consumer by accumulating a stock of material from which he could obtain motors, &c. Mr. Franks illustrated the drawbacks of unexpected changes in the conditions of supply. The variation in voltage was one thing that prevented manufacturers adopting electricity.

Mr. Watson, in reply, agreed with Mr. Frith's conception of the co-operative outlook of a municipal authority. Prices must be automatically adjusted to changes in cost of production. He was glad to have Mr. Frith's support of the rateable value system of charging domestic consumers which seemed the most satisfactory of all systems. The cost must, however, be reduced to make electric heating practicable. Mr. Pearce's figure for the diversity factor would closely approach his own if worked out on a similar basis—*i.e.*, if not extended to small users. He did not agree with the suggestion that a 40-hour week would bring the working hours within the convenient limits of 7.30 a.m.–4 p.m. In his experience, manufacturers would not readily rearrange their hours in order to get a supply at a lower rate.

A New Low-Power Lamp Rectifier of Alternating Current.

By JOHN SCOTT-TAGGART.

The writer is indebted to the Edison Swan Electric Company, Ltd., for permission to give details of a thermionic rectifier which he has recently evolved at their works. It was desired to design a rectifier which took the form of an electric lamp and could be plugged into the ordinary alternating-current supply. The required rectified current was in the neighbourhood of 100 milliamperes. It was decided that the most convenient method of obtaining direct current from an incandescent lamp would be to employ an elaborated application of what is termed the Edison effect.

Edison found that if a metal plate were inserted in an ordinary lamp and connection were taken from this plate through a milliammeter to the positive side of a filament heated by direct current, current passed through the milliammeter. If, however, connection from the plate were taken to the negative side of the filament no current was registered by the milliammeter. This interesting effect led up to the development by Fleming of the thermionic valve. The current through the milliammeter is due to electrons emitted by the filament which pass to the plate when the latter is at a positive potential with respect to a portion of the filament

The author decided to place a flat nickel plate between the two legs of the horse-shoe filament of spiralised tungsten wire. External connections were taken from the middle point of the filament, and also from the plate. Across these two external connections is connected the load through which the rectified current has to pass.

Let us assume that the potential across the filament is 240 volts. It will be seen that the potential of the plate will be practically the same as the potential of the middle point on the filament. Consequently, at the peak of one half cycle the plate will be at a potential of + 120 volts with respect to the negative end of the filament, and will consequently draw to itself electrons from that portion of the filament between the negative end and the mid-way point. Since the P.D. between the plate and the negative end of the filament will be the maximum value, the majority of the electrons will come from that portion of the spiralised filament. Since the plate will be negative with respect to the other half of the filament, none of the electrons emitted by that half will pass to the plate. When, however, the direction of the alternating current changes, the reverse process will take place. In this manner, there will always be a flow of electrons to the plate from one half of the filament; consequently, the device will act as a full-wave rectifier of alternating current, and will supply direct current suitable for use in valve receiving circuits and oscillators. By using filaments of greater diameter considerable rectified currents may be obtained, although currents of 1 ampere are not likely to be exceeded.

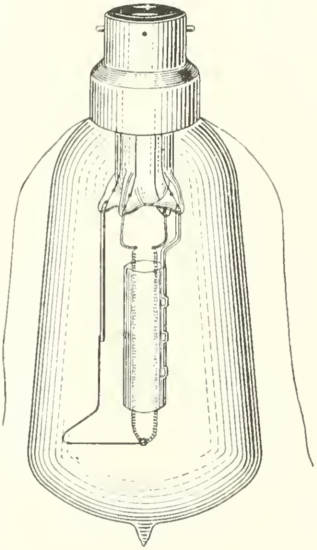


Fig. 1.

Since the plate is situated between two legs of the filament, the lamp may be used for ordinary electric lighting purposes as well as for use as a rectifier. It has, however, been found more efficient to enclose the two legs of the filament in a cylindrical anode The complete rectifier then presents the appearance shown in Fig. 1. In this case, however, the cylindrical anode shields the light from the filament. This form of rectifier has been used with considerable success on valve receiver circuits by connecting a large condenser of about 10 mfd. capacity across the rectified supply terminals. This condenser acts in the ordinary way as a reservoir from which the direct current is drawn.

Sir Robert Horne, President of the Board of Trade, has constituted his private office at the Board as follows: Principal Private Secretary, Mr. Cecil Litchfield; Second and Third Private Secretaries, Mr. C. Patrick Duff and Mr. E. W. Reardon; Parliamentary Private Secretary (unpaid), Mr. F. C. Thomson, M.P.

Correspondence.

THE SOUTHAMPTON DISPUTE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I desire on the part of the Electrical Power Engineers' Association to make the following statement:

This dispute hinges on the fact that Mr. Hooper, a member of the staff of the electricity undertaking, recently resigned his membership of the Electrical Trades' Union and joined the Electrical Power Engineers' Association. Mr. Hooper was formerly a charge engineer in the generating station, but in November, 1919, he was promoted to the position of station superintendent. In this capacity he was in charge of the maintenance of the plant and controlled a number of men, who were members of various unions, such as the A.S.E., &c. On his assuming this position he decided that he could not properly remain a member of the E.T.U., and consequently tendered his resignation, at the same time indicating his reasons for the step he was taking. His resignation was not at first accepted, but he insisted. In February, 1920, he became a member of the Electrical Power Engineers' Association because, in his opinion, it was the Association which included within its scope officials in electricity undertakings occupying positions similar to his own. Further though he had received benefits whilst a charge engineer, the grade which he now occupied was not covered by any E.T.U. Awards.

It might be pointed out here that the E.P.E.A. is a registered trade union, recognised by the Ministry of Labour and by Parliament. A Joint Board has also been set up, with the approval of the Ministry of Labour, between the employers representing the electricity supply industry and the E.P.E.A., for the purpose of dealing with wages, &c., for engineers occupying grades similar to that of Mr. Hooper.

When Mr. Hooper joined the E.P.E.A. he was quite a free agent. To suggest, as one daily paper has done, that he had been drawn away from the E.T.U. "by questionable means and specious excuses" is totally inaccurate. Further, there have been similar cases where men on account of promotion to a higher position have resigned from the E.T.U. and joined the E.P.E.A. as being a more suitable organisation, and no action has been taken by the E.T.U.

We are at a loss to understand why, if the E.T.U. felt they had a grievance in the matter, they have not taken the matter up before, as Mr. Hooper was accepted as a member of the E.P.E.A. in February. The first intimation that this Association received of their grievance was that the E.T.U. members had come out on strike, and our contention is that it would have been more reasonable on their part to have discussed the matter with the us before adopting such drastic measures.

The E.P.E.A. is very much inclined to doubt whether the present strike is an official one and has received the sanction of the E.T.U. executive, and it is for this reason that they are determined to support Mr. Hooper. Strictly speaking, this is not a strike, but a direct attack by one union against another, and the E.P.E.A. is bound to defend itself and its members even if it is compelled to adopt methods which, had it been an official dispute on a question of wages, &c., it would not have dreamt of adopting. We could not as a trade union question the right of the E.T.U. to bring pressure to bear upon an individual who was a non-member of a recognised trade union, but in the present case, seeing that Mr. Hooper is a member of a recognised trade union, nothing but strong exception can be taken to any form of coercion which would compel him to abdicate his right to act as a free agent in the choice of a union.

The dispute again brings into prominence the vexed question of the interlapping of trade unions and the necessity of having some line of demarcation drawn defining the proper spheres of operation of each. This the E.P.E.A. contend is a subject for the E.T.U. and the E.P.E.A. to discuss in joint committee, and not one for drastic action such as has been adopted in the present case.

Up to the present moment we have received no communication from the E.T.U., though we, ourselves, have endeavoured several times to get in touch with the London officials. It is this fact that strengthens our conclusion that the strike is unofficial, and has been embarked upon locally at the instigation of a few whose motives are largely personal.—I am, &c.,

London, W. Arthur Jones, General Secretary,
April 16. Electrical Power Engineers' Association.

WIRING FOR ELECTRIC LIGHT IN SMALL HOUSES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have been much interested in the article appearing in your last issue entitled "Wiring for Electric Light in Small Houses," by Mr. Alan Kirk.

In discussing the various systems Mr. Kirk comes to the conclusion that the screwed conduit system offers the greatest advantages. As you say in the leading article, this is a conclusion which you do not expect to see generally accepted—a view in which I am entirely at one with you. In considering the various systems of wiring he makes no distinction between rubber cables protected by a hard sheathing of durable tinned copper and those protected by a thin sheathing of lead, but dismisses them both with the remark: "they were very unsuitable for the wiring of small houses, their cost is comparatively high in both material and labour, safety is low and life is likely to be short."

Now in all cases an ounce of practice and experience is worth a ton of theory. The Fixed Price Light Company, Ltd., which was formed for the express purpose of wiring and supplying current to the houses of the working classes has now been in operation for over 10 years, during which time it has been supplying some thousands of consumers in Bermondsey, Waterloo and Wimbledon and other areas. The whole of the wiring in all cases has been carried out in "Stannos" wire, run on the concentric system, using the outer sheath as a return; a street or group of houses being supplied from a double wound transformer off the supply mains.

During the whole of that time there has not been a single accident, not a single installation has had to be renewed, and the fact that in a big area such as Wimbledon with thousands of lights in use one man has for years past carried out the whole of the work of upkeep, which includes replacing blown fuses, burnt out lamps, &c., on installations the average age of which is seven to eight years, thoroughly refutes Mr. Kirk's suggestion that the life of "Stannos" wiring under these conditions is liable to be short.

Again, he states that "Stannos" wire is only suitable for surface work. Although in the majority of cases the Fixed Price Light Company, Ltd., puts the wire on the surface, I believe that many people all over the country are burying it in plaster, and I know that some seven or eight years ago the whole of the offices of The Royal Insurance Company and of The British American Tobacco Company—each with a large number of points—were wired with "Stannos" wire at 200 volts two wire, buried throughout in plaster behind pile and marble work, and both these installations have, I am informed, worked without any trouble ever since.

Mr. Kirk, and also your other readers, may be interested to know that the Fixed Price Light Company, Ltd., uses ordinary heavy sheathing "Stannos" mains for distribution cables also, the system being to feed one end of the street from ordinary underground mains, and then carry "Stannos" mains down the side streets; these mains being run on the fronts of the houses and carried across gaps between the houses underground.

Throughout the whole of the operations of the Company a failure on the outside mains has been practically unknown and having regard to the large mileage of underground "Stannos," mains which have been in use now for the last eight or ten years, my Company have no hesitation in continuing to use copper sheathed wire both for interior and exterior work.

As the question of the best method, not merely of wiring artisans' dwellings, but also of charging for the current is of pressing importance at the moment, my Company will be pleased at any time by appointment to show you, Sir, or any one else interested in the subject, groups of houses wired on the Fixed Price Light system.—I am, &c.,

London, April 20. D. C. Meffan, Secretary.

[We have been obliged to hold over some Correspondence.—Ed. *E.*]

The Electrician.

FRIDAY, APRIL 23rd, 1920.

Price ONE SHILLING. By Post 1s. 1d. Ann. Sub.: U.K. 52s., Abroad 54s.

Editorial and Publishing Offices:

8, BOUVERIE STREET, LONDON, E.C.4.

Telephone: City 9853 (4 lines). *Telegrams:* "Benbrotric Fleet London."

Education and Finance.

The members of the House of Commons, whether taken collectively or individually, are very human. They crowd the historic chamber to view the introduction of a lady member and allow empty benches to vote the huge sums of money which the Government now seem to find necessary for carrying on the work of the nation. It is hard to say that they should be blamed for this. They are sent to Westminster to represent their constituents and it is abundantly evident that those constituents care very much more about the success of the local football team than they do about the Education Estimates. So that the average member has the excellent excuse that in neglecting to examine the votes which have to be accounted for by the Board of Education and the corresponding authorities in Scotland and Ireland he is really representing his constituents in the way they would do themselves if they were placed in a similar position.

Endowment of Research.

Nevertheless education and the financing of that education are important subjects. Indeed we do not hesitate to say that upon the right methods of instruction being followed depends very largely the future prosperity of the nation, while of equal importance is the need for spending judicially so that not only may money be saved at a time when every economy is essential, but that every penny paid out may be employed in the best possible way. The endowment of research and the financing of scientific investigation are essential in any progressive nation, and if the money is well spent no amount allocated to these branches can be too great at the present stage in our country's history. The Education Estimates for 1920-1921 are worth examination from these points of view.

Some Important Figures.

Following the example of most other Government Departments the Educational Authorities want more money than they had last year. The total sum asked for is £58,694,718, as against £43,211,190 expended in 1919-20, a net increase of £15,483,528. Large increases are required for the ordinary purposes of the Board of Education and for public education in Scotland and Ireland, while museums and similar institutions also account for small extra amounts. No exception will be taken to this. Indeed, it is very much to be doubted whether full use is made of our wonderful science and art collections, and it is certain that much greater use could be made of the scientific and engineering sections by judicious extra expenditure. It is some time since we last visited South Kensington, but our impression is that the electrical engineering exhibits are by no means up-to-date. Neither are they likely to be brought up-to-date in the near future when the ridiculously small sum of £3,500 is all that is allowed for the purchase of new apparatus. This miserliness is a pity in a district largely inhabited by students, and the reason is, principally, we fear, that neither politicians or Government officials realise that money spent on museums and on making their contents known is money spent in the best possible way.

Increased Sums for Scientific Investigation.

We are glad to see that the amount allocated to scientific research has increased from £271,453 to £518,298, and for scientific investigation from £126,971 to £208,416. Looked at as percentages these are substantial increases, but even now the sums are small enough in all conscience and it must be remembered that the votes for this work were among the first to suffer the pruning of which even Government Departments did a little during the war.

Of the sum allocated for scientific investigation £15,000, or an increase of no less than £9,000, goes to the Royal Society. £11,000 of this sum is for scientific investigation undertaken with the sanction of a Special Committee appointed for that purpose. £1,000 is allocated to scientific publications, £2,000 for subscriptions to International Research Associations, and the remainder goes in aid of the expenses of the Magnetic Observatory at Eskdalemuir. The Solar Physics Observatory receives £3,000, and the Imperial Mining Resources Bureau, which is doing exceedingly useful work receives £10,750, or slightly less than last year.

Material at the National Physical Laboratory.

The amounts allocated under the heading of Scientific and Industrial Research include a sum of £203,000 for the National Physical Laboratory, a net increase of £49,350. We are rather surprised, however, to see that the amount allocated for equipment and materials is no less than £14,370 smaller than last year. It would be interesting to know the reason for this reduction, which seems to be due to a largely decreased expenditure on materials and stores. No one has greater reason to be thankful for the work of the National Physical Laboratory than the electrical engineer, and we should certainly be the first to protest against any circumscription of its activities. It may be that with the large amount of war material available an opportunity has been taken to hand over useful stores to this Institution, and that consequently for the moment it has been possible to reduce the money grant. At any rate, we hope that there will be no attempt made to curtail in any way the work of real scientific importance that is being carried on at Teddington. A largely increased amount is allocated to the Fuel Research Station work on which at the present time is of an importance which can hardly be over-rated.

The Expenses of Universities.

There is no change in the amount, £916,000, for grants in aid of the expenses of Universities, Colleges and Medical Schools, while the sum voted last year in aid of certain Institutions of University rank which were in need of special assistance to enable them to resume their full work under favourable conditions and to prevent them being hampered by extraordinary expenditure involved by the prolonged interruption of their activities and development caused by the war has been reduced from £500,000 to £196,000. This is a good sign. It shows that reconstruction is beginning to work, and that the Universities are among the first to rid themselves of the lethargy engendered by the Government dole.

We are glad to see that the House of Commons is at last beginning to realise that it must exercise a closer control over Departmental expenditure. Its business, however, is not only to control, but to suggest. There are men of scientific eminence in Parliament. Some of their attention might be well turned to this question of financing scientific investigation and research.

Heating and Cooking Notes.

The Efficiency of Boiling Operations.

Apart from such questions of design as facility of replacement of elements, easy access for cleaning, &c., there is no doubt that the greatest room for improvement in electric cooking lies in increasing the efficiency of boiling operations. For baking, roasting, grilling, &c., electricity can hold its own with any other method; but where "cooking water" is indulged in to any extent it frequently happens that complaints are made regarding the cost. For boiling operations three methods are available:

1. The enclosed type of hotplate, which is dependent on conduction, necessitating the use of a flat-topped hotplate and a utensil with a machined or ground bottom. If the top casing of the hotplate is not of sufficient thickness, then after a short time it warps and the efficiency of conduction is spoiled. Also a thick-topped hotplate suffers from the disadvantage that a considerable amount of time is taken in heating up the top and body of the hotplate. It is then necessary to educate the cook either to switch off just before the water boils and use the residual heat to finish the operation, or to refill the kettle and warm a second quantity of water with the residual heat in the hotplate. The effect of this heating-up stage is shown in curve A, Fig. 1. It will be noticed that it improves in efficiency as the quantity of water boiled increases.

2. The radiant or open-type hotplate competes far more keenly with the enclosed than would be at first supposed, and it offers a distinct advantage where only small quantities of water, say, 1 pint, are employed. For egg boiling or for water for a cup of tea, the radiant type is certainly the more economical. These hotplates also offer the further advantage that it is not necessary to employ flat-bottomed utensils, and in these days the expense of purchasing a new set of machined bottomed utensils because electric cooking is adopted is a costly item. The radiant hotplate elements will withstand the effect of a "boil-over," and, generally speaking, it is a much easier job to replace the elements when necessary than is the case with the enclosed hotplate. In Fig. 1, curve B refers to a radiant hotplate.

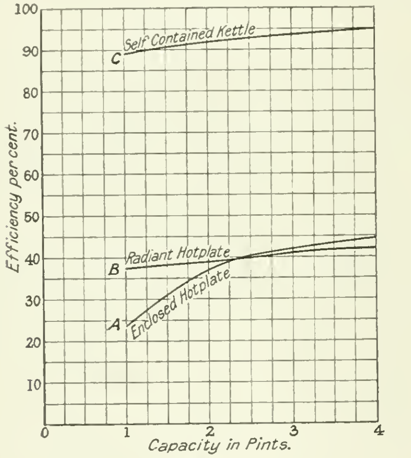


Fig. 1.—Efficiency Curves for Enclosed and Radiant Type Hotplates and Self-contained Utensils.

3. The self-contained utensil is the most efficient, and reference to curve C in Fig. 1 will show that these utensils are approximately twice as efficient as hotplates. Unfortunately, the cost of purchasing a set of self-contained kettles, saucepans, steamers, &c., is considerably more than the cost of a range plus the cost of a set of ordinary utensils. The greatest disadvantage in use is the risk of a "boil dry," but the average cook is on the look-out for such an event because the contents of any ordinary utensil are spoiled if boiled dry. The elements can be easily replaced and give good service.

The provision of an oven, mounted on legs to a convenient height to avoid stooping, and a table provided with a plugboard and switches on which could be used self-contained utensils, certainly offers a convenient and the most efficient solution to the difficulty. The grill could either be mounted above the oven or on the table. A shelf fixed above the table would carry utensils not in use, and room would thus be left for the table to be used in preparing the food, by which both the preparation and cooking of the food would be centralised, and many steps to and fro saved.

The "Magnet" Pedestal Heater.

The General Electric Company recently produced a small portable radiant heater, suitable for auxiliary heating, such as during piano practice, undressing, in the bathroom, &c. It is also serviceable for many cooking operations such as toasting, frying, boiling, stewing, &c. Essentially it consists of a parabolic copper reflector mounted on a pedestal and provided with a canting device for tilting the reflector to any desired angle. A detachable guard is fixed over the bowl, and this serves as a protection against clothing or inflammable material from coming into contact with the element, and also as a stand for the cooking utensils when the heater is used for this purpose. The element is of spiral form mounted on a grooved fireclay base, and connection is made by means of two plug pins which fit into two plug sockets. The element is loaded to 600 watts. This little heater attracted considerable attention at the recent Ideal Home Exhibition at Olympia, due to the heating effect caused by the concentrated reflection of the heat rays by the parabolic reflector. It is well made and finished, sufficiently robust in construction to withstand hard usage, yet light enough to be easily portable. The ease with which a spare element can be inserted, due to the plug pin connection, is a feature which is to be recommended. A consumer can quite easily replace a defective element with a new one, thus reducing the cost of repairs, and the elements themselves are quite inexpensive. Fig. 2 shows the heater being used to boil a kettle, whilst Fig. 3 illustrates the element. In addition to the standard type with black pedestal and copper reflector, the reflectors are also supplied finished antique copper or brass, or nickel plate or oxidised silver.

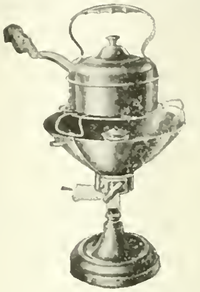


Fig. 2.—"Magnet" Pedestal Heater in use for Boiling a Kettle.

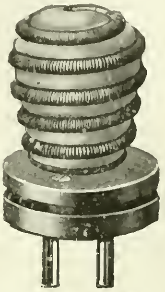


Fig. 3.—Element of "Magnet" Pedestal Heater.

District Council for London Electric Supply Industry.

The London District Council (Area No. 10) for the Electricity Supply Industry was recently formed, with Ald. J. A. G. Beaumont (Marylebone) as chairman and Mr. E. Cruse (Amalgamated Society of Toolmakers) as vice-chairman. The joint secretaries for the employers' side are Mr. Arthur J. Fuller, Electricity Works, Townmead-road, Fulham, S.W. 6, and Mr. A. F. Harrison, City of London Electric Lighting Company, Ltd., 1/2, Great Winchester-street, E.C. 2; and the secretary for the Union side is Mr. W. J. Webb, E.T.U., 14, Baldwins-gardens, Gray's Inn-road, E.C. 1.

The Members of the Council for the Employers are:—

Municipalities.—Ald. J. A. G. Beaumont (St. Marylebone), Councillor A. J. Bamford (Bermondsey), Major C. R. Attlee, J.P., M.A. (Stepney), F. A. Bond (Battersea), Arthur J. Fuller (Fulham), Councillor W. F. Goodrich (Watford), Councillor A. Attwell, J.P. (Walthamstow), Ald. Dudley Stuart, J.P. (Wimbledon), Councillor Geo. Croot (West Ham) and P. L. Riviere (L.C.C.).

Companies.—A. F. Harrison (City of London Company), Capt. W. R. Rendell (Metropolitan Company), F. C. McQuown (County of London Company), C. G. Staneshy (Charing Cross, &c., Company), H. W. Miller (Kensington & Knightsbridge Company), Mark Feetham (London Electric Corporation), R. S. Downe (Brompton & Kensington Company), H. P. Gaze (Central Electric Company), M. Farrer (Twickenham Company), K. A. Scott Moncrieff (Hendon Electric Supply Company).

For the Employees the members include three members each of the E.T.U., the National Union of Enginemen, Firemen, &c., the Workers' Union, and the National Union of General Workers, with one member of each of the following: Amalgamated Society of Toolmakers, the United Machine Workers, the Dockers' Union, the Steam Engine Makers and the Amalgamated Society of Engineers.

Silvertown Primary Batteries.

One of the earliest pieces of electrical apparatus to be put to industrial use was the primary battery. It is now about 120 years ago since Galvani and Volta's well-known experiments led to the production of the crown of cups which was the forerunner of the modern apparatus. The improvements made have, of course, been numerous, and a most important advance was made in 1868 when the cell produced by Leclanché was first invented. This cell was introduced into England in the same year by the India-Rubber, Gutta Percha & Telegraph Works Company, Ltd., who, as is well known, make a speciality of this type of cell.

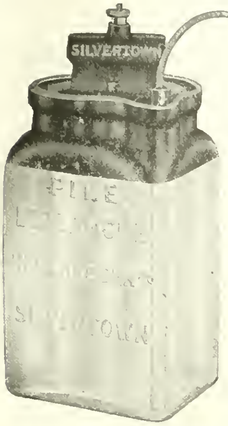


Fig. 1.—Silvertown Leclanché Cell, Porous Pot Form.

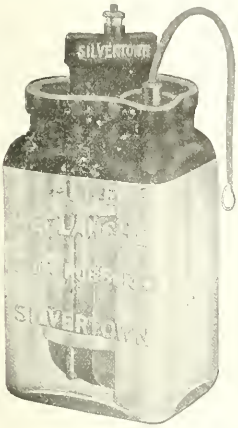


Fig. 2.—Agglomerate Leclanché Cell.

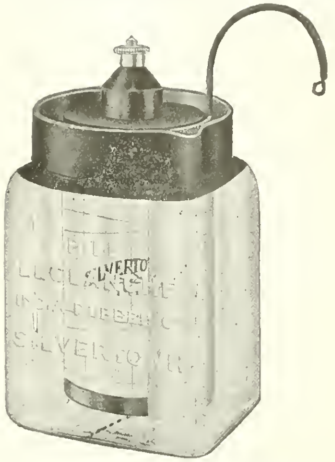


Fig. 3.—Sack Form of Leclanché Cell.

The Leclanché cells made by them are reproduced in several forms and types, and among the many attention may first be called to the porous pot form illustrated in Fig. 1. This is a standard pattern of a well-known piece of apparatus which is being used all over the country for bell ringing, telegraph and telephone work. In the Silvertown cells the greatest attention is paid to manufacturing details and only material of the highest quality is used. We understand that a recent discovery made at the works has allowed the manufacture of charged porous pots to be improved and has added considerably to their efficiency and endurance, but we are not permitted to know exactly what this discovery is. To eliminate every chance of faulty pots a percentage of each batch manufactured is submitted to a series of severe tests, and all batches of pots are kept in stock until these tests, which take from three to four weeks to carry out, are completed. If any pots do not pass this standard test the whole batch from which they are drawn is destroyed.

Another well-known type of Leclanché cells made by the Silvertown Company is the agglomerate form which is illustrated in Fig. 2. This differs from the cell we have just been describing in that agglomerate blocks of carbon are used instead of the porous pot. These blocks are placed one on each side of the carbon plate and are held in position by two india-rubber bands, the zinc rod being contained in a small porous tube. It is claimed for this type of cell that it utilises to a greater extent the depolarising power of the manganese with the result that the E.M.F. is more sustained and the internal resistance more constant. It is also found that the battery is not liable to become so clogged in its action and that the risk of breakage and deterioration in the cells is therefore much lessened. Renewals are easy to effect and the cost of doing so is much less than when a porous pot is used.

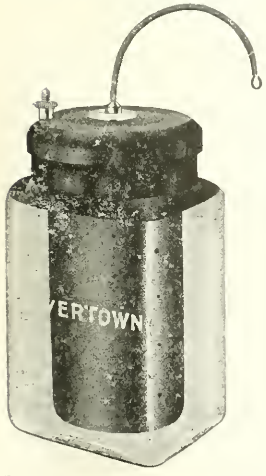


Fig. 4.—Central Zinc Type of Cell.

Another form of Leclanché cell made at Silvertown is shown in Fig. 3. In this type the porous pot is replaced by a negative element consisting of a rod of carbon surrounded by very tightly packed special depolarising mixture, the whole being contained in a sack of textile fabric. It should be pointed out that in this type of cell the sack is not sewn, and the trouble caused by the stitching coming undone is thus avoided. The zinc element consists of a large half cylindrical plate, and the combination of this with the absence of a porous pot reduces the internal resistance of the cell considerably, so that its output is almost double that of a cell of the same size with a porous pot. Fig. 4 shows a type of cell in which the zinc is placed in the centre, the negative carbon element being made in the shape of a pot with a suitable insulating base. The porous tube runs down the centre of the pot and the space between this tube and the pot is filled with a depolarising mixture. The zinc rod is placed inside the porous tube, which is perforated to allow free penetration of the electrolyte, while evaporation is minimised by the top of the carbon pot entirely closing the mouth of the jar. Besides these Leclanché cells, the India Rubber, Gutta Percha & Telegraph Works make primary cells of other types, including the bichromate, Bunsen, Daniell and Minoto, as well as dry cells of the ordinary pattern and of the inert type.

Electricity at the Building Exhibition.

There are a number of electrical exhibits at the Building Exhibition at Olympia, which closes to-morrow, April 24, and we give a few notes concerning them :—

The Lister Bruston automatic electric lighting plants made by R. A. Lister & Company, Ltd., of Dursley, Glos., for country house purposes are now well known, and a 1 kw. 55 volt set is shown in operation. The feature of this plant is that the supply is given direct from the generating plant except when the load falls to 5 per cent. or 10 per cent. of the normal. In this way battery loss is reduced. The engine in this case automatically starts and stops itself so that general attention is reduced to the minimum. A magnetic governor is fitted to the engine, which regulates the speed according to the load, thereby giving practically constant voltage at all loads. A new form of current breaker has now been fitted, which has advantages over the old dash pot type.

A lighting set of the usual form is shown by Messrs. Petters, Ltd., & Vickers-Petters, Ltd. This is a Petter Junior Electric Lighting set, comprising a Petter Junior engine coupled to a 2¼ kw. Metropolitan-Vickers dynamo generating current at 50 volts. As is now usual in this class of outfit, the engine is started up on petrol, but in a few minutes changes over automatically to paraffin.

The Metropolitan-Vickers Electrical Company, Ltd., has a fairly comprehensive display of small electrical apparatus, in addition to one of their 250 volt electric cooking ovens, which, as in the oven shown on the Carron Company's stand, is an exact replica in outward design of the conventional gas cooker. The small apparatus includes kettles, boiling rings, an electric bowl fire, which can be swivelled to the horizontal, and used for boiling, hot plates, glue pot, domestic iron, combined grill and toaster, &c. The company is also dealing largely in wood work, and wood blocks for wall switches, ceiling roses, &c., find a place. This part of the work belongs to the commercial woodworking department of Vickers, Ltd.

The Carron Company has two classes of electric cookers, one being designed for small houses and tenements of two or three rooms. This has the desirable feature of being raised off the ground and allows cleaning underneath to be done. The larger form is only a few inches off the ground, and cleaning is not so easy. Both types are double-cased and packed to retain heat, and are fitted with the usual boiling plates and griller. The company also makes a double oven roasting and baking range and a water boiler, which is fitted to a cast-iron stand. There are also a number of separate grillers, toasters and hot plates, which should be found useful in restaurant work and large buildings. The company lays itself out to instal complete equipments, and has some large outfits in munition and other factories and mills.

Three firms show electric lighting glassware and fittings, viz., Holophane, Ltd., Messrs. F. & C. Osler and Underwood (Manchester), Ltd. The first named exhibit consists of a complete range of the latest forms of prismatic illuminating glassware for correct light distribution and diffusion. There are Holophane standard line stiletto reflectors for both ordinary metal filament lamps and gas filled lamps up to 1,000 watts. These prismatic reflectors are made in three types, giving extensive, intensive and focussing light distribution to suit varying heights of buildings. A special type is the reflector-refractor, and a new design for interior lighting, employing a combination of reflective and refracting properties, whilst the special anti-glare device, which came out so well in the recent tests of motor car headlights is also shown. Messrs. F. & C. Osler have long had a reputation for artistic electric fittings, and a beautiful alabaster bowl is a striking feature on the stand. The firm is specially engaged at the moment in turning out fittings on mass production lines. Arms and brackets are made in large numbers, and are then adapted as component parts of particular designs in the finished article. The reproductions of this firm of "period" styles are noteworthy. The various fittings exhibited indicate the great popularity of bowl lighting.

Underwood (Manchester) Ltd., have also a fine display of lighting fittings, in which bowl types predominate. The glassware is the Canadian Moonstone illuminating glassware. It is neither opaque, like ordinary glass, nor transparent like crystal glass, but may be said to be between the two. The effect is certainly most pleasing.

Both Maryatt & Scott, Ltd., of Hatton Garden, and Waygoods, Ltd., exhibit their automatic electric lifts. In both, devices are fitted so that once a passenger has entered the car, the outside control is completely cut out until the car has reached its destination and the passenger has alighted. The Waygood automatic lift is a model, but a full-size lift to carry visitors to and from the gallery is arranged for dual control. Maryatt & Scott, Ltd., show a full size electric service lift working under ordinary conditions. This is automatically controlled by push buttons. In the passenger type a safety gear is fitted, which comes into operation in the event of the stretching or failure of the lifting ropes, and sustains the load by securely gripping the guide runners. The car is shown fully loaded supported by this safety gear. There is also on this stand a range of standard controlling equipment including safety lift locks, and passenger and service type gears and controllers. The generous proportions and interchangeability of all wearing parts is noticeable.

British Electric Vehicles, Ltd., show the B. E. V. electric industrial trucks, which are manufactured in five different standard patterns and capacities, and are now familiar to all who use the large railway termini Ironclad Exide batteries are used on these little vehicles, and the rated mileage is 20 to 25 miles per battery charge. A safety plug is fitted in the main circuit, which can be removed when the vehicle has to be left.

Alloy Welding Processes, Ltd., exhibit samples of electrically welded structural steelwork using the A.W.P. process, instead of being riveted, whilst tramway engineers will be interested in the samples of real welding shown.

Motor Car Lighting.

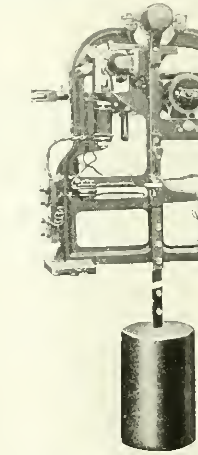
The high efficiency of modern electric lighting systems has contributed immensely to the popularity of night motoring. Night-driving has always possessed a certain fascination for the romantically inclined, but in the days of oil and acetylene lamps the pleasure was marred by the well-justified feeling of uncertainty as to the reliability of the lighting. Electric lighting is inherently free from these troubles, and, moreover, is infinitely simpler to operate than other methods of illumination. To obtain completely satisfactory service from an electric lighting system it is, however, necessary to pay careful attention to the choice of lamp bulbs. In 99 cases out of 100 where motorists have had trouble with their electric lighting, it has been due to poor or improperly rated bulbs.

An electric lamp bulb may appear to be a very simple appliance, and so it is in theory and operation; but in its manufacture, testing and rating the most scrupulous care is required. On the constructional side the filament must be of correct and uniform diameter, and made on the drawn-wire principle, so that it may possess the degree of physical strength necessary to withstand the jolts and jars of ordinary service. The bulb must be completely exhausted, otherwise the filament will quickly disintegrate through oxydisation; and the cap must be accurately dimensioned and securely fastened to the bulb that neither moisture nor vibration will loosen it. A bulb constructed like this will only operate satisfactorily when it is used on the proper voltage. The voltage at which a bulb should be operated is marked on the cap or glass, and the determination of this voltage is a matter of careful manufacture and accurate testing. A careless or unscrupulous manufacturer, having a demand for 8-volt bulbs, may by inadvertence or deliberate intention mark 8 volts on a batch of bulbs which ought to be marked 6 volts. A motorist buying such lamps would, at first, be gratified by their unexpected brilliance, but in a short time would be annoyed by their premature failure.

Bulbs made by reputable British manufacturers can be relied upon in regard to their rating, but there are at present a great many bulbs on the market, which do not carry the implied guarantee of a known and advertised trade mark; and there is always a certain risk of bad construction or improper rating in the case of such products. Most of these unknown bulbs are of continental or American manufacture, so that there is also a patriotic reason for not buying them. A timely reminder of the importance of correct rating is afforded by a perusal of the British Thomson-Houston Company's "Lamp Bulb Guide for Car Lighting," recently noticed in these columns. This extremely useful handbook describes the various types of the famous Mazda lamp bulbs, and gives full information in regard to voltage, watts and ampere rating. The end section of the handbook contains an alphabetical list of all British, European and American cars and motor cycles in use in the United Kingdom, with a tabulation giving the necessary particulars to enable one to select the correct Mazda bulb for use in the headlights, sidelights or tail lights of any one of the models shown. Trade readers may obtain a copy of Handbook 3-A. from the British Thomson-Houston Company, Ltd., 77, Upper Thames-street, London, E.C. 4.

A Large Electric Clock.

Messrs. Gent & Company, Ltd., Leicester, have recently carried out a smart piece of work in connection with the installation of an electric clock at St. Pancras for the Midland Railway Company. On March 20 the firm received instructions to electrify the large clock under the Arcade and install one of their "Waiting-Train" movements behind the dial. Although no preparatory work had been done, by the afternoon of the following Friday (March 26) the large face had been cleaned, the hand mechanism adjusted, a new "Waiting Train" movement installed, and the whole of the electrification of the clock completed and going by 4 p.m. on that day. The clock is 18 ft. across, only a few feet smaller than Big Ben of Westminster, and, as a single dial clock, it is the largest electric clock in London. The "Waiting-Train" mechanism used for driving this dial is a small compact piece of apparatus, occupying a space about 18 in. square. The motive power for driving the hands is obtained from the pendulum, through the medium of a ratchet wheel and the usual crown gear. The accuracy of the time-keeping is not, however, dependent upon this, but the pendulum is arranged to have a slight gaining rate, and moves the hands with steady motion through a half minute space on the dial in about 27 seconds. At this point a masking pawl comes automatically into operation, and stops the drive. Exactly on the half-minute the impulse from the master transmitter releases the masking pawl, and allows the drive to continue. The hands, therefore, do not proceed in half-minute impulses, as in the case of small clocks, but at a uniform rate, with small periods of "waiting." The pendulum is self maintaining, and is capable of developing up to nearly 30 times its normal power, so that wind or snow pressure on the hands of the clock cannot effect its time-keeping qualities.



The Mechanism of the St. Pancras Clock.

The Ministry of Labour has appointed Sir David Shackleton, K.C.B., and Sir James Masterton-Smith, K.C.B., to be Joint Permanent Secretaries of the Ministry of Labour. The growing pressure of business at the Ministry has made it necessary to appoint a joint permanent secretary who will take administrative control of the Department, and thus free Sir David Shackleton for the discharge of his increasing duties as chief labour adviser.

Legal Intelligence.

Harvey v. London Electric Railway Company.

On Monday Mr. Justice Roche awarded the plaintiff in this action (Mrs. Harvey) £275 damages for injuries caused while she was trying to enter a train at Baron's Court station on the "Piccadilly Tube." Plaintiff said that the guard started the train before the gates were closed, and that, while she had one foot on the platform and the other on the footboard of the train, she was thrown down and suffered serious injury.

Cinema Electric Supply.

Last week a Divisional Court (Bray and Bailhache, J.J.) heard an appeal brought by the Paignton Electric Light Company from a decision by the County Court Judge of Paignton in respect of an overcharge which Mr. Linsdell, the proprietor of a local Cinema, alleged he had paid under a contract for the supply of electricity to the Cinema.

After hearing legal arguments Mr. Justice Bailhache, in giving judgment, said respondent, desiring electricity for his cinema, applied to appellants who agreed to supply it for lighting purposes and also at a lower rate for that used for power. The question was whether the energy supplied was to be charged at the lower rate of 3d. per unit for power, or at 7d. for lighting. The judge below decided in favour of respondent. The electrical energy was used except in regard to a small portion for light in an arc lantern. The dispute arose because the electrical energy passed through a transformer to lower the voltage from 440 to 60 volts. The question was whether the electricity was used for lighting or for power, and in his opinion it was for lighting, only a small portion being supplied for operating films. The amount in question could be agreed among the parties.

Mr. Justice Bray concurred and the appeal was allowed, with costs.

Workmen's Compensation.

At Chesterfield County Court last week the Chesterfield Tube Company applied for the diminution of a compensation award granted to William Horrobin, electrician. It was said there had been a change of circumstances since the last hearing, when the Judge decided that the work offered was not suitable. The work now offered was that of coil winding for 1-h.p. motors and it could easily be performed by the man. The wage was £3 13s. 6d. per week.

On behalf of Horrobin it was said his condition had not changed. The Judge, however, made a declaration of continuing liability, but reduced the compensation to one penny per week. He thought the pain suffered by Horrobin was to some extent imaginary, and that it would probably largely disappear if he had the courage to persist in doing the work. If he found that he could not really do the work he would be at liberty to come and have the case re-opened.

Charge for Specification.

In the City of London Court last week, Mr. Reg. Williams, trading as "Y" Electrical Installation Company, sued the Paddington Radical Working Men's Club, Ltd., for 10 guineas for services rendered with reference to an electrical installation. Plaintiff stated that one of his men told him that the club was inviting tenders for an electrical installation. He saw the secretary, and was asked to give a special specification, and also an estimate in accordance with the club's own specification. He sent two specifications. The club decided to adopt the original specification, notwithstanding that he had been asked for his suggestions in writing. He now claimed a fee of 10 guineas.

The secretary of the club said that a notice inviting tenders was placed in the club. Tenders were received from five firms, and plaintiff tendered in common with others. He was not asked to do anything more than each of the other firms. He did not employ plaintiff professionally to evolve any new scheme.

Judgment was entered for defendants, with costs.

Rist v. Valco Magneto Company.

A partnership purchase of Government magnetos gave rise to an action heard by Sir F. Newbold, Official Referee, on the 13th, 14th and 15th inst., in which Mr. David V. A. Rist, trading as the Valco Mfg. Company, claimed from the Valco Magneto Company and Mr. Herbert Rothwell the delivery of 90 magnetos or their value, and damages. The original claim was for the delivery of 140 magnetos, but by order of Mr. Justice McCardie 50 of that number had been delivered.

It appeared that in 1917 the Government desired to sell a number of magnetos stored at the White City which had belonged to the Royal Air Force. Why the Admiralty was anxious to get rid of the magnetos did not transpire, but Mr. Rist tendered for them, and his tender was accepted. For the purpose of carrying out the purchase he entered into partnership with Mr. Rothwell, under the title of the Valco Magneto Company, and that partnership continued from Dec. 17, 1917, until Nov. 20, 1918, at which latter date it was dissolved, and the business of the defendant firm was afterwards carried on by Rothwell in partnership with one Stanley James Watson. In October, 1918, defendant firm assigned to plaintiff for £220 the whole of their stock of the B.T.-H., T.B. and Bosch (D.U. 5) magnetos, with some further T.B. and B.T.-H. magnetos. On the same date plaintiff assigned to defendant Rothwell, for £110, 90 of the magnetos. It was alleged that defendant had not completed the transaction, and that he had wrongfully detained certain of the magnetos. It was a term of the sales that Rothwell should deliver to plaintiff within reasonable time, but it was alleged that he had failed to do so, and a claim of some £600 was made for non-delivery, with damages for detention.

The defendant denied liability, alleging that it was a matter of account, and counterclaimed against plaintiff for breach of contract. There was also a minor claim by defendant Rothwell for small sums relating to the partnership prior to the dissolution amounting to £56. 8s. 3d.

Plaintiff's counsel said that the magnetos were considered so valuable that they were deposited on the first floor of the company's premises in Long Acre. From that moment Rothwell, who was conducting the business of the company, endeavoured to dispose of some of the magnetos, with the result that in October, 1918, there were left out of the 200 only 180, consisting of 100 D.U.5's, 46 T.B.'s and 34 B.T.'s. At that time certain financial arrangements were made between the parties under which Mr. Rist bought the whole of the 180 magnetos from the firm for £220. Further transactions took place, but in the result plaintiff was unable to obtain delivery.

A great deal of evidence was taken on both sides, chiefly relating to the financial transactions between the parties and the condition of the magnetos and parts purchased. In relation to their value it was stated by plaintiff that the stock was insured for £2,000, and that a number of them which were bought for 7s. 6d. each were resold on the same day for £4. 10s. each.

After several witnesses had been heard, the Official Referee suggested the desirability of the parties considering whether a settlement could not be arrived at, and for this purpose the parties agreed to an adjournment.

Rejax Electric Lighting Plants.

Electrical engineers who have seen the Rejax power and lighting plant are enthusiastic about it, because it follows the best principles of British design, its generator armature, commutator, field windings, &c., being liberal in size, while the same thing applies to the engine and bedplate. It will run cool under a heavy load for a long period and its governing is very sensitive, while valves, timing gears, governing mechanism, &c., are completely enclosed and are deluged with oil while the engine is working. The plant stops automatically when the batteries are fully charged while the meter on the switchboard registers the ampere-hours in or out of the battery, showing clearly on a dial the state of charge of the battery at any time. To start up the plant one has only to press the starting button after turning on the fuel tap. The automatic cut-in and cut-out looks after the switching arrangements. Many householders, small hotel proprietors, farmers, shop-keepers and others are now desirous of putting in electric lighting installations to a much greater extent than before, and as the Rejax plant can be run practically without attendance and by quite inexperienced people, it should appeal strongly to this class of customer. Further, the modest price and the simplicity of its installation brings the total cost within the reach of a much wider class. Agency arrangements are now being made with electrical engineers all over the Kingdom and interested readers may obtain particulars from Messrs. Rejax, Ltd., 3 & 4, Percy-street, Tottenham Court-road, London, W. 1.

For the farm or estate the Rejax plant is particularly designed. Placed in any barn or out-house it can drive a line shaft which has pulleys belted to chaff-cutters and other food preparing machines, while the same shaft can be arranged to pass along into the dairy to drive the churn and separator. While the engine is performing these farm operations it is charging the accumulators automatically. These accumulators yield a supply of electric current at any time for lighting the house, farm buildings, &c. Quite apart from the obvious advantages of electric light and power for operating machines which were perhaps hitherto worked by manual or horse labour, the electric light is actually far cheaper than oil or gas, however derived. The Rejax Company carry large supplies of all requisite fittings for electric lighting, power, &c.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices, on receipt of published price, plus postage.]

"Electrical Practice in Collieries." By Daniel Burns, M.I.M.E. (London: Chas. Griffin & Company.) Pp. x.+497. 10s. 6d. Fifth Edition.

"Water Powers of British Columbia." By A. V. White. (Ottawa: Canada Commission of Conservation.) Pp. x.+644.

"Electric Lighting in the Home." By L. Gaster and J. S. Dow. (London: Sir Isaac Pitman & Sons.) Pp. 31. 6d. net.

"The Use of Low-Grade and Waste Fuels for Power Generation." By J. B. C. Kershaw, F.I.C. (London: Constable & Company.) Pp. x.+202. 17s. net.

"Half-Past Twelve: Dinner Hour Studies for the Odd Half-Hours." By G. W. Gough. (London: Sells, Ltd.) Pp. 77. 1s.

"Continuous Current Machinery." By Dr. S. P. Smith. (London: Benn Brothers, Ltd.) Pp. iv.+60.

Whittaker's Electrical Engineers' Pocket Book. Edited by R. E. Neale, B.Sc. Fourth Edition. (London: Sir Isaac Pitman & Sons.) Pp. xi.+671. 10s. 6d. net.

Commercial Topics.

Excess Profits Duty Decisions.

Among recent decisions of the Board of Referees on application for increasing the statutory percentage of profits exempt from excess profits duty are the following:—

Spelter and Tubes.—Applications of Swansea Vale Spelter Company and Weldless Tube Association and British Tube Association. Percentage raised to seven.

Aluminium.—Application of British Aluminium Company. Percentage raised to seven and a-half.

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Spanish Developments.

According to recent reports the industrial activity due to the war shows no signs of abatement, and there is at present a very keen demand for machine tools, mining and textile machinery, &c. It is proposed to erected important new iron and steel works at Hamar, which will include blast furnaces combined with Martin furnaces and electric furnaces. The company will also have a department for manufacturing railway and tramway rolling stock and a wire-rolling mill. Like all modern works, the electric drive will be used throughout. Various hydro-electric schemes are also being developed and for some years there should be a good field open to British manufacturers and exporters.

* * * *

The Columbian Electrical Market.

Prior to the war the supplies of electrical machinery for Colombia came from Germany and the United States, but it is now reported that the trade has become an American monopoly. An important British company has decided to establish an agency in Bogotà, with a depot in Barranquilla, whence material can be transferred to any point in the Republic. The business is said to be capable of considerable expansion, as there is a need for electric lighting and plants on coffee estates and mining properties, and there is no reason why British plant and fittings should not supersede some of those at present sold. In Bogotà there is a British telephone company which imports British material when possible, but American telephones have been installed and sold in other parts of the Republic.

* * * *

The Brush Company.

The Brush Electrical Engineering Company, which is probably the oldest manufacturing company in the industry, appears to have had a very successful year and the prospect for the future seems to be bright. The company has had its ups and downs, but we are gratified to see that it is now in a prosperous condition. The trading profit for 1919 was nearly £224,000 against £157,800 in 1918 and £89,229 in 1917. A dividend of 15 per cent. has been declared, £70,000 has been placed to reserve and £183,399 carried forward, against 18 per cent. in 1918 (which included 6 per cent. for each of the years 1914, 1915 and 1918), and a carry forward of £34,714. The report states that normal manufacturing operations were rapidly resumed after the Armistice and that in both the engineering and car-building departments important contracts have been completed and are in hand. The demand for the Brush-Ljungstrom steam turbine electric generating plant and auxiliaries has developed so satisfactorily that new extensions of buildings and plant have been put in hand, and the capital of the company is to be increased by £346,220 in order to provide money for these extensions and to build houses for the employees.

* * * *

Electrical Progress in Shanghai.

According to the recent report of the Shanghai electricity undertaking, the demand for energy has exceeded official expectations. The original estimate for 1920 allowed for a load of 34,000 kw., but it has been necessary to increase this to 45,000 kw. It is therefore proposed to retain a portion of the Fearon-road steam generating plant which it had been decided to remove. Though the German plant at Riverside is unreliable, it is proposed to make the best of it for the time being, and it will therefore be retained until two more 18,000 kw. sets are installed. In the meantime the German plant at Riverside is to be considered as equal to 10,000 kw., instead of its stated capacity of 14,000. The anticipated load of 64,000 kw. for 1921 demands further large extensions of plant. It is expected that two more 18,000 kw. machines will be in commission by the autumn of 1921. By June, 1922, it is proposed to install two 10,000 kw. turbines, and then the German plant will be removed. No. 1 power house is to be enlarged, and designs are being drawn up for a new power house, which will have to be in commission by the end of 1923. Eight new boilers have been ordered, and it is now necessary to order two more—*i.e.*, a total of 10 boilers, instead of eight originally scheduled for No. 3 boiler house. Tenders have been received from both Messrs. Babcock & Wilcox and the Stirling Boiler Company, and it has been decided to order three more boilers from each company. This arrangement will enable the department to compare the relative merits of the two types of boiler under identical operating conditions. In addition to the generating plant, new buildings and extensions, and a large quantity of switchgear, transformers, cables, &c., will be required. The total capital expenditure during 1920 is estimated at Tls. 4,006,000.

It appears that the demand for power for industrial purposes is growing rapidly, while the electric heating and cooking load is steadily developing. Consequently there is a good sale for motors, heating and cooking apparatus.

Electricity Supply.

A committee of four has been appointed to report upon the best means of introducing electricity supply into Lanark.

Chesterfield Corporation has decided to spend £50,000 on additional generating plant and £5,000 on cable extensions.

Among the recommendations of the Southport Reconstruction Committee is one for the erection and equipment of municipal electricity show rooms.

Brierfield Council has made representations to the Corporation regarding the necessity of making long overdue connections for new electricity customers.

Nelson Corporation have received sanction from the Electricity Commissioners to proceed with the extensions to their electricity works and also authority to borrow £152,000.

The Watch Committee of Sunderland Corporation has authorised the Weights and Measures Department to purchase an electric motor for power purposes in connection with the work of that department.

Doncaster Corporation have received sanction to proceed with the installation of two additional 3,000 kw. sets and water-tube boilers, &c. The extension involves an expenditure of £120,000.

It is stated that the preliminary estimates for the Bridge and Dam Across the River Severn near Chepstow, by means of which it is proposed to utilise the 40-ft. tide in generating electric power, put the cost at between £6,000,000 and £8,000,000.

In regard to the proposal to link up the electricity undertakings of Sheffield and Rotherham Corporations, the Ministry of Transport has been informed by Sheffield Corporation that power will be required from Rotherham as soon as the linking up arrangements can be effected.

Complaints were made at Oldham Council meeting last week of the long delay in connecting prospective consumers of electricity, but the vice-chairman of the Electricity Committee (Councillor Frith) explained that the department was extraordinarily busy at present, and people must wait their turn; he had to wait nine months before receiving his own supply.

Manchester Corporation propose to send a deputation, including the city electrical engineer (Mr. S. L. Pearce), to the United States, in order to study the latest practice in the operation and lay-out of extra-high-tension transmission and distribution systems, and to report upon the latest developments in design and operation of large stations for the economical production of power.

Owing to the cost, the proposal to establish a Super Power Station for the East Midlands has been abandoned, and instead the existing stations in the area will be extended. At Leicester these extensions will cost about £600,000, and at Nottingham a similar sum will have to be expended. Loughborough will be called upon to spend about £150,000 and Derby £120,000.

Cardiff electric supply department are unable to keep pace with the demands for electric current, and the engineer and manager (Mr. Morley New) states "that nearly the whole time of his clerical staff is taken up by informing people that they cannot extend their cables." As soon as possible the supply cables are to be extended to boarding houses in Bute Town.

The Electricity Commissioners have consented to the extension of Shoreditch Borough Council's Whiston-street electricity station. The Lighting Committee report that, in connection with the extension of plant approved by the Commissioners (at an estimated cost of £118,495) it is necessary to provide a new sub-station in Evelyn-street. The Committee propose to ask for quotations from the Metropolitan-Vickers Electrical Company and the British Thomson-Houston Company for switchgear urgently required.

Already Mr. Geo. Balfour and 30 other members have put down motions for the rejection of the new Electricty (Supply) Bill, and it would appear that the measure is likely to meet with strenuous opposition in both Houses of Parliament. The Bill reproduces, with one or two small amendments, the provisions of last year's measure as passed by the House of Commons which were struck out by the House of Lords. A full abstract of the original Bill appeared in The Electrician for May 16, 1919.

A successful first session's work in connection with evening classes for the workmen and staff of the Glasgow Corporation Electricity Department was brought to a close on April 14, when Mr. R. B. Mitchell chief engineer and manager of the department, presented the prizes to the best students. There were four classes, viz., a practical class in instrument making; a class for generation and distribution for the clerical staff; a class in arithmetic and algebra; and a class in electrical theory.

Ayr Corporation has been considering the question of obtaining a supply of electricity in bulk from Kilmarnock Corporation, and in a report the Kilmarnock engineer and manager (Mr. W. C. Bexon) stated that to get the best possible results Ayr should sell its present generating plant and take the whole of their supply from Kilmarnock. He suggested that Ayr Corporation should guarantee a minimum consumption of not less than £6,000 a year. The price proposed is £3 per kilowatt of the maximum demand, plus 0·5d. per unit, Ayr Corporation to provide a suitable sub-station near Monkton, and the agreement to be for a period of 20 years. The proposal has been referred to Mr. J. H. Rider, consulting engineer, for a report.

Electric Traction.

The recent tramway strike in Manchester, Salford and Oldham involved a loss of over £60,000 in receipts.

The Bolton branch of the Tramway & Vehicle Workers' Association has asked that double pay shall be paid to all drivers, conductors and the inside staff on each of the four days in August during which the annual show of the Royal Lancashire Agricultural Society is to be held at Bolton, but the Tramways Committee has declined to accede to the application.

In a communication to Deptford Borough Council the Minister of Transport states that the Technical Committee to the Advisory Committee on London Traffic are about to take into consideration a general scheme for the development of tube railway facilities, and that when the matter is further advanced the committee will be glad to consider any evidence which the council may desire to give as to the extension of such facilities to South-east London.

Two interim reports have been presented to the Ministry of Transport by the Departmental Committee on Lights on Vehicles. The questions dealt with include the number of lamps to be carried on various types of vehicles and the restriction of the use of dazzle headlights On the latter question, it is agreed that some of the headlights now in use are unnecessarily powerful. The Committee recommend that the light given by all headlights should comply with some standard of illumination ascertained at various points. "With a view to fixing such a standard as will be satisfactory, they propose to subject all ideas and devices submitted to them to a series of practical road tests by experts under all conditions." Pending this investigation, the Committee suggest certain limitations on the size of clear glass aperture of head lamps (of which there should be only two) and on the power of the electric bulbs or acetylene burners. Legislation is recommended for altering the lighting-up time for vehicles, to make permanent the present rules that a front light or lights and a red rear light must be carried on vehicles, with certain exceptions. In regard to the number and capacity of lamps, not more than four lamps showing a light to the front to be permitted on any vehicle (except a vehicle with a load that overhangs laterally); not more than one separate rear light to be used, except in the case of projecting loads; all acetylene burners and electric bulbs used in lamps showing a light to the front shall have clearly and indelibly marked thereon their capacity or power, and shall not exceed 24 c.p.; if more than two lamps showing a light to the front are used, two of them must be side lights not exceeding 12 c.p. each. There are provisions recommended for overhanging and projecting loads, &c.

Telegraph and Telephone Notes.

Concessions have been secured by the Compagnie des Cables Sud-Americains (a French company) for establishing and working submarine and terrestrial telegraphic communication between Montevideo and Buenos Aires, and a submarine cable between Montevideo and Rio de Janeiro.

Work is proceeding on the erection of new telephone exchanges at Bishopsgate, Golder's Green, the Tower, Stratford and Hendon. The Tower exchange, which is nearing completion, will contain 10,000 lines. Extensions are also being made to the Barnet, East, Hampstead and Harrow exchanges, while at New Cross and Willesden the extensions are finished. The supply of skilled labour is now sufficient, as the majority of the men in the Army have been released, but the handicap of the high cost of materials for the manufacture of cables and instruments remains.

It is announced that, as a result of long-distance wireless telegraphy experiments which are being made between this country and the occupied part of Germany, it is hoped that in a short time it will be possible to transmit messages at the rate of 150 words a minute. In reply to a question on this subject by Mr. R. McNeill, it was stated by Mr. Churchill in the House of Commons on Monday that at the Experimental Establishment at Woolwich wireless messages had been transmitted over considerable distances at the speed of 100 words per minute, and very much greater speeds had been obtained under laboratory conditions only. Rapidity of transmission was of the highest importance to the Army and the other fighting services, as in the near future wireless telegraphy would be the primary means of intercommunication in those services.

In an article on "Wireless Wonders and Press Possibilities," the "Newspaper World" of April 3 suggested the possibility of employing portable wireless sets by pressmen for sending reports over a radius of 10 to 20 miles. It was also suggested that every editor should secure the services of an enthusiast on his staff in order to watch developments in wireless telegraphy and telephony, while newspaper proprietors were recommended to urge upon the Postmaster-General the desirability of granting facilities for experiments on the lines indicated. In the issue of our contemporary for April 17 the Marconi Company, while denying the suggestion that it had neglected to interest itself in the problems of wireless as applied to news gathering, state that the directors of the company are of opinion that wireless telegraphy and telephony will contribute a great deal to the cheap and rapid transmission of newspaper reports. Since the war the company has had the press problem under careful consideration, and has laid the foundations upon which it is hoped an organisation of great newspaper value will rapidly grow. The proposals are intended to provide equal facilities for all recognised news gatherers and to afford such assistance to rapid and flexible communication as can be given by a company operating on commercial lines. In the opinion of the company the indiscriminate employment of wireless sets would not benefit newspaper proprietors, and would be unlikely to receive official sanction.

Imperial and Foreign Notes.

The value of the railway and tramway plant imported by New Zealand in 1919 was £269,350, compared with £52,214 in 1918.

Owing to the extension of the electric lighting plants at Khartum and Khartum North, it is reported that considerable quantities of electric lamps, wire and other material are required.

Mr. R. Morse has been appointed electrical design engineer in the Tasmanian Government hydro-electric dept. Mr. E. F. Du Rieu has also been appointed engineer for electrical construction work by the dept.

Mr. H. S. Dix, late manager of the Prahran and Malvern (Victoria) Tramways Trust, has been appointed acting chief manager and engineer for the Melbourne and Metropolitan Tramways Board.

Lithgow (N.S.W.) Council must make arrangements either to increase the capacity of the gas works, at a cost of several thousands of pounds, or install electric supply plant, but as a temporary expedient Mr. W. Corin advises the Council to enter into an agreement with Messrs. C. & G. Hoskins & Company to supply electricity. In regard to the form the permanent supply should take, there are three alternatives: (1) The Council to establish a scheme of its own; (2) the Railway Commissioners to provide a power station at Lithgow, and the Council to take a bulk supply; (3) Messrs. Hoskins & Company to provide a by-product recovery oven at Lithgow, and the Council to purchase a bulk supply from the firm. The last mentioned proposal may be adopted.

It is announced that the General Electric Company (U.S.A.) has secured the contract for the conversion of the Paulists Railway, Brazil, to electric traction. The work will be begun immediately, and will, it is said, be one of the largest railway electrifications in the world. The double track between Juniahy and Campainas will be electrified, and a 4,500 kw. station will be erected at Louviers. This is the most important scheme of electric traction that has been proposed in South America.

An extensive scheme of hydro-electric development and for the conversion of certain railways to electric traction has been submitted to the Swedish Government by the Board of Waterfalls. The work will, it is proposed, be carried out in 1920 and 1921, and will involve a total expenditure of 19 million crowns. It is estimated that the transmission lines at present conveying electric power from the three power stations at Trollhättan, Alfkarleby and Motala are about 2,962 kilometres, and the number of stations distributing the power over the country is 241. The greater part of the Provinces of Västergötland, Bohuslän and Dalsland, the whole of Uppland and Södermanland and great portions of Gästrikland, Dalekarlia, Västmanland, Nerke and Ostergötland are already covered, but it is proposed to erect 2,000 kilometres of lines and erect 220 distributing stations. It is suggested that a thorough co-operation, or linking-up arrangement, between the power-stations should be introduced by means of a transmission main line between Trollhättan station in the west and Alfkarleby power-station in the east to begin with, to be followed in later years by similar connections with the big stations in the north and south of Sweden.

Miscellaneous.

The late Sir John Jackson, engineer and contractor, left estate of the value of £520,474, with net personalty £504,674.

The well-known electric light switching examinations, which were conducted with such success by Messrs. Lundberg during the years previous to the war, have again been resumed, and the Papers for the next examination will appear in the columns of our contemporary "Electricity," commencing with the issue for April 23.

At a reunion dinner of the officers of the Tyne Electrical Engineers, on the 17th inst., Lieut.-Col. C. R. Toomer, V.D., who recently relinquished command of the unit after 28 years' service, was presented with a framed oil painting, "Searchlights at Portsmouth," by W. L. Wylie, R.A. In 1914 the unit was divided into two; one section went to Portsmouth for duty and the other portion remained with the Tyne Garrison. The latter maintained the coast defence electric light plant at the Tyne, and also installed new defence electric light plant at Blyth and Sunderland, the original anti-aircraft light stations of Tyne Garrison.

A charge of failure to earth electric wires was preferred against Messrs. Coulson & Company, of Spennymoor (County Durham), at the local Petty Sessions on Tuesday last. Mr. W. Lauder, factory Inspector, said the wires in question were connected with a portable dribbling machine. When attempting to move the handle an employee operating the machine received a shock of 230 volts, and as a result was laid up for a month. The defence was that all the usual precautions were taken and that recommendations of the Factory Inspectors were invariably followed. The Bench dismissed the summons on payment of costs, but it was intimated that an appeal would be lodged.

In a report on the collision which occurred between two trains at Soothill Wood Colliery, on the Leeds-Batley branch of the Great Northern Railway in February, Major Hall states that the severe storm at the end of January caused extensive damage to block telegraph and telephone wires in the district, and traffic was still on this branch being operated under the block telegraph regulations. It is of great importance that the duration of traffic operation under these regulations should be reduced to a minimum, and he agrees with the opinion expressed by Col. Pringle that the Temporary Installation of Telephone Block Working by means of insulated cable run out from reels would be of the greatest value pending restoration of normal conditions.

Institution Notes.

The Friday evening discourse before the Royal Institution on May 7 will be delivered by Lord Rayleigh on "The Blue Sky and the Optical Properties of Air."

Mr. H. B. Poynder, hon. sec. of the N.E. Centre of the INSTITUTION OF ELECTRICAL ENGINEERS, stated at the recent annual meeting that the membership during the past session had increased from 291 to 389.

A meeting of the LIVERPOOL WIRELESS ASSOCIATION was held on the 14th inst., when an interesting Paper on "Valve Action and Circuits" was read. Several new members were elected to the committee, and Mr. Irvine being elected chairman and Mr. S. Frith hon. secretary.

The annual general meeting of the ELECTRICAL TRADES' BENEVOLENT INSTITUTION will be held on Monday next at the offices of the Electrical Contractors' Association, 11-13, Southampton-row, London, W.C., to receive the report for 1919, to elect members of the committee of management, &c.

A licence, under sec. 20 of the Companies (Consolidation) Act, 1908, has been issued by the Board of Trade to the SCOTTISH SHALE OIL SCIENTIFIC and INDUSTRIAL RESEARCH ASSOCIATION, which has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. Communications to Mr. W. Fraser, C.B.E., Scottish Oils, Ltd., 135, Buchanan-street, Glasgow.

The concluding meeting of the third session of the GLASGOW ELECTRICITY DEPARTMENT ENGINEERING SOCIETY was held on the 12th inst., Mr. R. B. Mitchell, chairman, presiding over an attendance of 96 members. Mr. C. W. Marshall, laboratory superintendent, delivered an able Paper on "A.C. to D.C. Transformation," which was followed by an interesting discussion. During the past winter the Society held 14 meetings with an average attendance of 80. Mr. Mitchell announced that arrangements were already well in hand for next session's syllabus.

At the final meeting of the Session of the Birmingham & District Electric Club on the 17th inst. a Paper was read by Mr. F. D. Davidson on "The History and Development of Electric Heating and Cooking." The writer gave a short history of the experiments and difficulties of the pioneers in America, Germany and England. With lantern slides and examples the writer showed most of the early forms of heating elements and discussed the advantages and disadvantages of each different type. He expressed the opinion that for water boiling and the like, the mica wire strip element, bolted in close contact to its work, was the most efficient heating element yet devised, and for heating the porcelain former type of fire bar, the most effective. A plea was made for some attempt at standardisation of heating elements, and the suggestion was made that the most useful size of element for general purposes was an element 5 in. long by $1\frac{1}{4}$ in. wide and not more than 3/16 in. thick; this could be used singly or in suitable numbers for practically all forms of apparatus, the loading and voltages being varied to requirements.

At the jubilee meeting of the EDINBURGH ASSOCIATION OF SCIENCE AND ARTS on the 9th inst., Prof. T. Hudson Beare delivered an address on some of the important developments of science during the past 50 years. He dealt with the difference in this country now and in 1869 in the spirit with which science was looked upon by the Government. In 1851 the Government began to give a small annual grant of £1,000 a year for the promotion of research, and in 1877 this was raised to £4,000. It was only after a strenuous fight that they got the Government of 20 years ago to sanction the establishment of a national physical laboratory; but it was not until 1918 that the National Physical Laboratory was placed upon a satisfactory footing. That small laboratory now contained seven distinct departments of scientific research, and its staff had grown from 16 to 600 active workers. Scientific research was of immense value to us as a great industrial nation. Dealing with the development of electric power, he mentioned that in New Zealand remote little villages, much smaller than Highland villages, were provided with electric power, electric milking machines and churns. All the manual labour could be done, even on the isolated farms, by the electric energy distributed over large and sparsely populated areas. The New Zealand farmer was free from a lot of the drudgery and hard labour that our farming classes had to put up with during the winter and spring months.

Educational.

His Majesty the King has consented to lay, in July next, the foundation stone of the new Chemical Laboratories of EDINBURGH UNIVERSITY. The new chemistry school will take £250,000 to complete.

The certificates at the CRYSTAL PALACE SCHOOL OF ENGINEERING were distributed on Saturday by Sir Alfred W. Smithers, M.P., chairman of the Grand Trunk Railway.

Mr. Francis A. Heron, of Holywood, co. Down, has given a sum of £5,000 to QUEEN'S UNIVERSITY, BELFAST, in order to provide the necessary equipment for teaching physical chemistry, and a further sum of £1,000 towards the provision of accommodation for the department.

The following appointments to entrance scholarships at FARADAY HOUSE ELECTRICAL ENGINEERING COLLEGE have been made:—To Frank D. Goodchild (County School, Beckenham), a Faraday Scholarship of 50 guineas per annum, tenable for two years in college and one year in engineering works; to Geo. J. Moody (Alleyn's School, Dulwich), a Maxwell Scholarship of 50 guineas for one year in college and one year in engineering works

Personal and Appointments.

Mr. E. Harper, A.M.I.E.E., has been elected a member of the American Institute of Radio Engineers.

Prof. T. Hudson Beare has been appointed a deputy lieutenant of the City and County of the City of Edinburgh.

Mr. W. E. Miller has resigned his position as manager of the Carron Company's electrical cooking and heating department and has taken over the electrical cooking and heating department of Messrs. Archibald Low & Sons, Ltd., Markland Works, Partick, Glasgow, who intend to develop this branch very considerably in the near future.

Business Items, &c.

Mr J. C. Elvy, consulting electrical engineer, has opened a London office at 12, Tavistock-street, Covent Garden, W.C. 2.

Messrs. Tiptaft, Ltd., have removed their business to their new works at Holyhead-road, Handsworth, Birmingham.

The new address of the Secretary of the Machine Tool and Engineering Exhibition, which will be held at Olympia in September, is 70, Victoria-street, London, S W. 1.

Owing to increasing business, Messrs. W. J. Furse & Company, electrical engineers and manufacturers, have been compelled to extend their works at Traffic-street, Nottingham.

Alfred Ernest Wilson and Jas. Newton, dealers in electrical accessories, &c., 65, Market-street, Manchester, have dissolved partnership. Debts by Mr. Wilson, who continues as Wilson & Newton.

The partnership between Herbert Thos. Wright, Chas. Wright and Percy C. Maidment (trading as Wright Bros. & Maidment), electrical engineers and contractors, has been dissolved. Debts in respect of the business carried on at 164, Sloane-street, London, S.W.1, will be received and paid by Mr. Maidment, and those in respect of the business carried on as Wright Bros. & Company at 251, Fulham-road, S.W.1, by Messrs. H. T. & C. Wright.

Bankruptcies and Liquidations.

Horace Hy. Shave (trading as H. H. Roberts), electrician, 228, Sultan-road, Portsmouth, has been adjudicated bankrupt.

The Spanish & General Wireless Trust, Ltd., is being wound up for the purpose of reconstruction, and the liquidator, Mr. S. Pears, 14, George-street, Mansion House, London, E.C. 4, has been authorised to consent to the registration of a new company to be named the Spanish & General Corporation, Ltd., and to enter into an agreement with such new company. A meeting of creditors will be held at 14, George-street, on April 29.

Obituary.

The death is announced of PROF. JOHN A. McCLELLAND, Professor of Experimental Physics at University College, Dublin. Deceased, who was 50 years of age, was a Commissioner of National Education in Ireland.

The death has occurred of CAPT. E. W. CREAK, C.B., F.R.S., a former Superintendent of Compasses of the Admiralty Hydrographic Department. Deceased was 84 years of age.

Dr. RUDOLPH MESSEL, who died in London on Sunday, was a distinguished industrial chemist, and until recently he was managing director of Messrs. Spencer, Chapman & Messel, chemical manufacturers. Dr. Messel was the inventor of the catalytic process of manufacturing fuming sulphuric acid, which was patented in 1875.

We regret to announce the death, which occurred suddenly on Saturday, of Prof. A. K. HUNTINGTON, A.R.S.M., M.I.M.M., Professor of Metallurgy at King's College from 1879 until October last. In addition to his work as professor at the college, he carried out important research work in aeronautics and in motor car design.

On Sunday last the death occurred suddenly of Prof. L. T. O'SHEA, for many years Professor of Applied Chemistry at Sheffield University. Deceased made a special study of the chemistry of fuel, particularly in connection with coke oven development and the preparation of fuel for industrial purposes. Prof. O'Shea, who was educated at Owens College, was the author of several works on applied chemistry.

The death is announced of Mr. WILSON WORSDELL, for about 20 years chief mechanical engineer to the North-Eastern Railway Company. He retired in May, 1910, when the directors appointed him consulting mechanical engineer. Mr. Worsdell designed many famous engines built at the Gateshead shops, and he was associated with the scheme for the adoption of electric traction on sections of the railway.

The telegraph and telephone world has suffered a severe loss by the death of MR. THEODORE N. VAIL, president of the American Telephone and Telegraph Company. During the 10 years he was president of the company the "Bell" telephone system in the United States increased from under 6,000,000 to nearly 12,000,000 stations, and New York was put into communication with San Francisco. Mr. Vail, who was a man of ideas, had early seen the possibilities of the telephone as a general means of rapid communication, when he became president of the American Company he adopted the policy of universal service and uniform efficiency. He encouraged his technical staff to solve difficulties and he organised an elaborate research staff. He had been in failing health for the past year, and had retired from the active presidency of the Company, though remaining chairman of the board and retaining his active interest in the great work of telephone development. Mr. Vail, who was in his 75th year, was associated with Mr. Graham Bell for some years, and he initiated many enterprises connected with electricity supply, tramways and telephony.

Tenders Invited and Accepted.

Launceston (Tasmania) Corporation require tenders by 3 p.m. June 7 for one 1,000 k.v.a. Hydro-turbo-alternator, with Switchgear, &c. Specification from the City Electrical Engineer.

Falkirk Parish Council require tenders by May 8 for about six months' supply of electric lamps, &c. Forms of tender from Mr. John Macpherson, Poorhouse, Falkirk.

Rathmines & Rathgar Urban Council require tenders by April 28 for supply of house service cable, house service and fuse boxes Particulars from the Electricity Works.

Manchester Tramways Committee require tenders by April 27 for electrolytic copper and bronze trolly wire and steel fish plates. Specifications from the general manager, 55, Piccadilly, Manchester

Dingwall Corporation require tenders by May 7 for electric wiring work in connection with the erection of 35 houses. Specifications from the Architects, Messrs. Mackenzie & Macdonald, or Mr. D. Matheson, Dingwall.

Glasgow Tramways Department require tenders for 6 or 12 months' supply of stores and materials, including brake blocks, wires, castings, ironmongery, oils, varnish, &c. Specifications from the General Manager 46, Hope-street, Glasgow.

The "Gaceta de Madrid" of March 14 states that tenders will be opened on May 18 at the Spanish Ministry of Development for a concession for the construction and working for 60 years of an electric tramway from Corunna to Sada.

Cardiff Corporation invite tenders for the supply and erection of a 5,000 kw. turbo-alternator and surface condensing plant. Specifications and forms of tender from the Electrical Engineer, The Hayes, Cardiff, and tenders to the Town Clerk by April 29.

Tenders are invited up to May 5 for supply and delivery to the Postmaster-General's Department, State of Western Australia of insulators, bolts, brackets, &c. Specifications from the Commonwealth Offices, Room 406, Australia House, Strand, London, W.C. 2.

Dundee Corporation has placed an order for switchgear with Messrs. Fergusson, Pailin, Ltd., at £4,600.

The Dublin United Tramways Company, Ltd., have ordered an Orwell electric tower waggon from Messrs. Ransomes, Sims & Jefferies.

Sunderland Corporation has accepted the following tenders:—British Insulated & Helsby Cables, Ltd., house service, e.h.t. and l.t. cable; Brush Company, two 250 k.v.a. transformers; Jos. Thompson & Company, creosoted red-wood capping and cable troughing.

Shoreditch (London) Lighting Committee has accepted the tender of the Edison-Swan Electric Company for 1 mile of twin telephone cable, £96; and that of the Union Cable Company for 2½ miles of seven-core pilot cable at £300 per mile.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1917 Specifications.

139,226 Seymour & St. Helens Cable & Rubber Co. Electric cables or conductors. (22/6/17.) (Cognate Application, 11,528/17.)

1918 Specifications.

119,474 Seimbille. System for the instantaneous and electrical heating of water. (28/9/17.)
123,060 Murray. Method of electric welding. (6/2/18.)
135,817 Elektro Osmose Akt.-Ges. (Graf Schwerin Ges.) Electro-osmostic process for removing water from materials. (20/10/17.)
139,238 Wood. Machines for winding motor armatures. (22/11/18.)
139,241 Frattola, Castelli & Regnoni. Telegraphic systems. (9/12/18.)
139,245 B.T.-H. Co. (G.E. Co.) Motor installations for systems of ship propulsion. (30/12/18.)
139,836 B.T.-H. Co. (G.E. Co.) Automatic regulating systems for dynamo-electric machines. (8/11/18.)
139,843 Fentone. Electric furnaces. (21/6/19.)

1919 Specifications.

123,765 Salto. Alternating-current limiting apparatus. (28/2/18.)
125,943 Remy Electric Co. Connecting devices for electric circuits. (22/4/18.)
127,812 Electro-Agricultur Aktiebolaget. Cables for electrical machines adapted to be coiled and uncoiled. (7/6/18.)
128,575 Bethenod. Methods of indirectly coupling a radio-telegraphic antenna to a high-frequency alternator. (15/3/18.)
133,703 Soc. d'Electricite Mors. Electrical apparatus for operating railway signals. (4/10/18.)
139,259 Roberts & Matson. Electric telegraphs. (22/1/19.)
139,254 Leitner & Exley. Charging-boards for electric accumulators. (29/1/19.)
139,255 Hossack. Electric dry batteries. (29/1/19.)
139,277 Reid. Electric motors for operating pumps and for other purposes. (12/2/19.)
139,235 Berry. Electric and gas ovens, stoves and like appliances. (17/2/19.)
139,296 Hepburn. Mon-polar electrode electrolysers. (22/2/19.)
139,306 Western Electric Co. Electric printing telegraph machines. (7/3/19.)
139,338 Van Raden & Co. & Smith. Grids for the plates of electric storage batteries. (25/6/19.)
139,416 Fuller & Ross, Courtney & Co. Electric couplings. (20/8/19.)
139,418 Krone. Electrical alarm or door security devices. (25/8/19.)
139,440 Soc. des Moteurs Salmson. Means of fastening a cover on a magneto frame. (10/9/19.)
139,849 Parker & Parker. Electric terminals. (20/1/19.)
139,855 Frankel. Electric lamp sockets. (30/1/19.)
139,861 Western Electric Co. & Amberg. Telephone instruments. (8/2/19.)
139,867 Turner. Methods of using three-electrode ionic tubes, applicable for wireless telegraphy and other purposes. (17/2/19.)

Comprises a combination of two three-electrode ionic tubes, so connected together through batteries and resistances that a rise of grid potential of the first produces fall of grid potential of the second, which in turn produces rise of grid potential of the first, with arrangements for controlling the extent of this retro-action, so that any change produced in the system by an applied E.M.F. is reinforced and tends to be perpetuated, but, nevertheless, does not produce instability, and ceases when the applied E.M.F. is removed.

139,876 Railing & Garrard. Circuits of incandescent lamps. (26/2/19.)
139,881 Binns. Heating by electrical means and to any desired temperature metal rings or bands of any shape or size. (1/3/19.)
139,889 Railing, Garrard & Wilson. Step-by-step mechanism for electric motor-starters. (11/3/19.)
139,890 Clarke. Trolley heads of electric tramcars and the like. (11/3/19.)
139,897 Haran & T field. Electrical switches. (22/3/19.)
139,900 Western Electric Co. (Western Electric Co.) Automatic switching apparatus for telephone exchange systems. (25/3/19.)
139,904 Thompson. (Brochard.) Holders for wireless detecting crystals. (2/4/19.)
139,907 Tousey. X-ray film carriers. (3/4/19.)
139,913 Browne & Heywood & Co. Cable conduits for electric travelling cranes (5/4/19.)
139,915 Curtis. Rheostats. (8/4/19.)
139,919 B.T.-H. Co. (G.E. Co.) Automatic welding devices. (11/4/19.)
139,967 Cunningham. Preparing aluminium or its alloys for electroplating. (4/6/19.)
139,972 Murray & Telephone Mfg. Co. Electric switches. (10/6/19.)
139,973 Angell & Angell. Electrically-heated laundry irons. (11/6/19.)
139,994 Railing & Connaughton. Electrical signalling apparatus. (17/1/19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

December 1, 1919.

29,862 Taylor. Means of distribution on alternating-current systems.
29,869 Turnock. Switches, &c.
29,883 Lunn, Primrose & Manuel. Suspension of electric lamp shades.
29,889 Schroder. Electromotor with self-contained reducing gear. (17/9/14, Germany.)
29,933 Sargent. Electric lamp shade holder.
29,935 Alexanderson. Radio receiving systems. (18/4/19, U.S.)
29,936 B.T.-H. Co. (G.E. Co.) Signalling systems.
29,940 Electric Boat Co. Submarine boats. (5/2/19, U.S.)
29,955 Pennefather & Price. Adapters for electric light fixtures.
29,977 Akt. Ges. A.G. Switches. (13/6/19, Germany.)
29,980 Colner Elektromotorenfabrik, J. Bruncken. Induction Motors. (7/2/18, Germany.)
29,984 Colvete. Switches.
29,986 Brown. Polar inductor and revolving armature magnetos.

December 2, 1919.

30,009 Barker. Bases for trolley poles.
30,020 Cleary & Philpott. Controlling consumption of electricity.
30,047 Telephone Mfg. Co. & Palmer. Microphones.
30,048 Murray. Telephone receivers.
30,060 Brook & Eck. Electric switches, &c.
30,062 & 30,063 B.T.-H. Co., Clough & Taylor. Windings of alternating-current machines.
30,119 Colner Elektromotorfabrik, J. Bruncken. Induction motors. (22/3/19, Germany.)
30,120 Colner Elektromotorfabrik, J. Bruncken. Induction motors. (17/7/19, Germany.)

December 3, 1919.

30,125 Barter. Dynamo-electric machines.
30,128 Taylor. Methods of distribution and transmission on alternating-current systems.
30,130 Clark. Thermionic valve detector amplifier.
30,134 Jamie. Switches.
30,155 Hallowell. Combined commutator and cut-out for high-tension magnetos.
30,161 Scott Taggart. Thermionic devices.
30,176 Callender's Cable & Construction Co. Measuring electric cables.
30,185 Jones. Plugs and sockets for electrical fittings.
30,191 Rotax Motor Accessories Co. & Hill. Electric lamps for motor vehicle dashboards, &c.
30,207 Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maats. Thermic telephone systems. (4/12/18, Holland.)
30,212 B.T.-H. Co. (G.E. Co.) Electrical apparatus.
30,215 Edison Accumulators, Ltd. Variable pressure control of circuits operated from batteries.
30,220 Craig, Macnaughtan, Mather & Moore. Manufacture of electrolytic iron.
30,230 Haefely et Cie. Insulators. (13/9/19, Switzerland.)
30,231 Alber. Electric lamps. (13/12/18, Switzerland.)
30,237 Carolan. Electric scrubber, &c.
30,254 Decorat & Testavin. Starting and speed regulating apparatus for electric motors of vehicles, &c. (4/12/18, France.)
30,266 Automatic Telephone Mfg. Co. Automatic or semi-automatic telephone systems. (10/3/19, U.S.)
30,269 Graf. Junction boxes, &c., for electric circuits.
30,270 Graf. Switches. (16/5/19, Germany.)

December 4, 1919.

30,306 Taylor. Methods of transmission in alternating-current circuits.
30,339 Hall. Protection of electrical connectors.
30,355 Makower. Thermionic valves, &c.
30,356 B.T.-H. Co. & Young. Dynamo-electric machines.
30,358 Siemens Bros. Dynamo Works & Wilson. Dynamo-electric machines.
30,359 Siemens Bros. Dynamo Works & Jantzen. Dynamo-electric machines.
30,392 Andrews & Say. Electrified door handles.
30,396 Julien. Magneto-electric machines. (27/8/19, France.)

December 5, 1919.

30,441 Liguori. Direct-current series shunt motor.
30,442 Liguori. Single-phase transformer.
30,445 Ward. Electromagnetic low-tension sparking plug.
30,479 Schroeder. Cooling or ventilation of dynamo-electric machines.
30,480 Highfield & Calverley. Electric converting apparatus.
30,485 B.T.-H. Co. (G.E. Co.) Conducting leads for electrical apparatus.
30,487 Crowther & Robertson. Electromagnetic wave signalling apparatus.
30,488 Crowther & Robertson. Electromagnetic wave reception apparatus.
30,494 Foster. Thermo-electric couples.
30,495 Galer. Electric motor controllers.
30,509 Heafe. Arc lamps.
30,520 Soc. Anon des Ateliers de Secheron. Resistance heater for furnaces. (28/12/18, Switzerland.)

December 6, 1919.

30,534 Filbar Electric Heater, Ltd., & Kratt. Electrical water-heating apparatus.
30,558 Blake & Slater. Electric lamps.
30,588 B.T.-H. Co. & Clough. Voltage control of generators and motors.
30,608 Knudsen. Electric safety fuses. (8/3/19, Denmark.)

December 8, 1919.

30,654 Collins & Morrison. Electric animated phototelegraphy.
30,674 White. Amplification of electrical effects resulting from action of light on selenium cells.
30,680 Aspinall. Electric locomotives.
30,681 Weaving. Electrically heated irons.
30,691 Glover & Co. & Claremont. Aerial conductors and supports for same.
30,694 Merryweather & Sons. Electrically operated pumps.
30,695 Merryweather, Burford & Osborne. Electrically operated pumps.

Companies' Reports, &c.

The directors of Erinoid, Ltd., have declared an interim dividend at the rate of 15 per cent. for the past half-year.

The directors of Doulton & Company, Ltd., have declared a dividend of 5 per cent. on the preference shares for the past year.

The directors of the Hastings and District Electric Tramways Company have declared a dividend of 3 per cent. on the preference shares on account of 1919. A sum of £2,500 has been placed to depreciation and £526 carried forward.

The accounts of the Cleveland & Durham Electric Power Company for 1919 show, after transferring £14,000 to reserve for plant, renewals and improvements, and including £12,305 brought forward, an available profit of £38,613, against which has been charged £25,282 for interest on debentures, leaving £13,331, which has been carried forward.

The Calcutta Electric Supply Corporation, Ltd., has declared a final dividend for the half-year ended Dec. 31, of 6 per cent. (actual), making 10 per cent. for the year, on the ordinary shares, and a bonus of one preference share for every 10 ordinary shares held. For the corresponding period last year the dividend was 6½ per cent. (actual), and a bonus of 1 per cent., making 11 per cent. for the year.

The Eastern Extension Australasia & China Telegraph Company, Ltd., has declared a final dividend for the year ended Dec. 31, 1919, of 5½ per cent., and will be paid on the 15th prox. This will make the distribution for the year 10 per cent., tax free, against a dividend of 6 per cent. and a bonus of 2 per cent., together equalling 8 per cent., for the previous year. The share register will be closed from May 7 to 14 inclusive.

An extraordinary general meeting of the City of London Electric Lighting Company, Ltd., has authorised an increase of the capital to £2,000,000 by the creation of shares of the nominal amount of £800,000. There is no immediate prospect of issuing the whole of the new capital, but some of it may be wanted for the scheme outlined at the recent annual meeting. Each of the £10 preference and ordinary shares will be converted into 10 shares of £1 each.

The income of the Consolidated Electrical Company, Ltd., for the year ended March 31 was £11,167, and after meeting general charges and income-tax, and adding £2,352 brought in, the total was £11,436. The directors have applied £5,001 in writing off irrecoverable bad debts, and after paying the preference dividend, the directors recommend a dividend on the ordinary shares of 3½ per cent., leaving £1,685 to be carried forward. The directors contemplate the re-arrangement of the capital.

The report of the Bath Electric Tramways, Ltd., for 1919 states that, after charging £22,330 for repairs and renewals and including the £2,699 brought forward (after deducting £3,381 for special expenditure), the balance is £27,055, and after providing for debenture interest and the preference dividend, the balance is £16,751. The directors have transferred £12,500 to contingencies and renewals account, and recommend that the balance of £4,251 be carried forward.

At the recent meeting of the Bishop's Stortford, Harlow & Epping Gas & Electricity Company it was reported that, after many difficulties and a long period of delay occasioned by the war, the electricity plant was brought into use towards the close of the half-year, several consumers being connected with the Company's supply. The chairman (Mr. E. L. Burton) said the electricity plant was working smoothly and well, and it was anticipated that during the current year a large number of consumers would be supplied with current.

The report of the Cuba Submarine Telegraph Company, Ltd., for 1919 states that the total receipts were £78,852, while the expenses amounted to £26,603, and after providing £2,584 for cable repairs, £6,300 for income-tax and £15,000 on account of excess profits duty for 1918 there remains £28,364, which with £22,486 brought forward makes a total of £50,850. The sum of £10,000 has been added to general reserve and £2,500 to pension fund. The directors recommend a final dividend at rate of 5 per cent. per annum on the ordinary shares, making 5 per cent. for the year, together with a bonus of 4s. per share, carrying forward £21,150. Several repairs to cables in shallow water have been effected during the year at a cost of £2,584.

The net profit of Clayton & Shuttleworth, Ltd., for 1919 was £77,716. A dividend of 8 per cent. is proposed on the ordinary shares, carrying forward £53,496. The whole of the foreign debts and investments affected by the war, and amounting to £520,219, have been provided for. In order to develop the new undertakings known as the Titanic Works, the Abbey Works and the Clayton Forge, a new company styled "Clayton Waggons, Ltd.," has been registered with a capital of £1,000,000. The whole of the 550,000 £1 ordinary shares will be taken by Messrs. Clayton & Shuttleworth in consideration of the transfer of the works.

The capital expended by the Merthyr Electric Traction & Lighting Company, Ltd., during 1919 amounted to £1,944. Revenue was £39,211, an increase of £6,413, but expenses, owing to higher wages and additional cost of coal and other materials, show an increase of £5,602, leaving a net improvement of £810. After deducting expenses, including £2,923 for debenture and other interest and providing £5,000 for renewals, the surplus is £5,469, which, with £212 brought forward, makes available £5,681. The directors propose placing to reserve £1,200, and a dividend at the rate of 6 per cent. per annum on the ordinary shares, carrying forward £581. The revenue of the electricity supply department amounted to £18,053, and of the traction undertaking to £20,801.

At the recent annual meeting of the Newmarket Electric Light Company, Ltd., it was reported that during 1919 the equivalent of 1,882 33-watt lamps had been connected to the mains, making the total 35,692. The profit amounted to £2,351, against £2,156 in 1918. Deducting debenture interest £710, and adding £412 brought forward, a sum of £2,053 remained. In view of the greatly-increased and still rising cost of plant and machinery, the directors recommended that £1,750 be carried to reserve for renewal of plant, and that the balance be carried forward. Mr. F. E. Gripper, who presided, said that owing to the connection of new consumers and the extension of old consumers' demands, the Company had added quite a considerable load to their mains, and had increased its output by about 10 per cent. Revenue had increased by about £960, but this was practically swallowed up by increased costs. The company had increased its charges by only about 33 per cent.—from 6d. to 8d.—whereas everything else had gone up 100 or 150 per cent. or more. They had applied to increase their rate to 10d. per unit. If they could only get a reasonable price for what they were selling there was no reason why they should not be able to make a reasonable return on their capital.

The Folkestone Electricity Supply Company, Ltd., reports that up to Dec. 31 last the equivalent of 181,827 8-c.p. lamps was being supplied, an increase of 13,330 8-c.p. over those connected in December, 1918, being the largest increase in any year since 1903. The price of current was advanced to 8d. per unit from the beginning of the year and as a consequence the receipts show a substantial increase, although the cost of fuel, &c., has continued to increase. The increased charges were made consequent on an application to the Board of Trade under the provisions of the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, and one of the provisions of the orders sanctioning such increase was that the Company might during the continuance of the orders pay a dividend of not more than 4¾ per cent. per annum upon its ordinary capital. Including the receipts from hired installations, the profit on the revenue accounts for the three undertakings amounts to £14,302 15s. 10d., which, with £964 18s. 6d. brought forward and interest on investments, &c., together with excess profits duty and income tax recovered during the year and after allowing for interest on debenture stock and dividend on preference shares, shows a balance of £11,016 12s. 5d. Out of this, the directors have carried £7,702 11s. 10d. to depreciation fund, and they recommend payment of a dividend at the rate of 4¾ per cent. (less tax) on the ordinary shares for the year, which will require £2,375, leaving £939 0s. 7d. to carry forward.

The report of the Brush Electrical Engineering Company, Ltd., for 1919, states that the liquidation of war contracts in hand at the beginning of the year was expedited in every way possible, with the result that the Company was quickly in a position to resume its normal manufacturing operations. In both the engineering and car building departments important industrial contracts have been completed and numerous others are in hand. In particular, the demand for "Brush-Ljungstrom" electric power plant and auxiliaries has developed so satisfactorily as to necessitate a further enlargement of the Company's manufacturing capacity, and important new extensions of buildings and plant to meet this demand are in progress. The profit and loss account shows, after providing for general charges, maintenance of plant and buildings, and interest on the debenture stocks, a balance of £148,685, making, with £34,714 brought forward, a total available balance of £183,399, subject to excess profits duty in respect of the years 1918 and 1919. The directors recommend that £9,500 be allocated to depreciation of buildings and plant and £600 to depreciation of patents and goodwill, a further 4 per cent. interest on the prior lien participating second debenture stock will absorb £2,045; £70,000 is to be placed to general reserve and after paying a dividend at the rate of 15 per cent. on the ordinary stock for the year (£15,787), a sum of £85,568 remains to be carried forward. The sum of £54,163 12s. 3d. has been expended on capital account during the year. In order to provide for the extensions of buildings and plant now in progress, to cope with the largely increased business in hand and in prospect, and to build houses which will in a measure help to solve the problem of finding accommodation for the increasing number of employees, the directors recommend that the capital of the Company be increased by the creation of 346,220 new ordinary shares of £1, thus raising the authorised capital to £600,000, part of which new capital it is proposed to issue at an early date. In view of former reductions of capital the directors recommend that £105,244, part of the general reserve fund, be capitalised and distributed to the present holders of the ordinary stock.

At an extraordinary general meeting of Callender's Cable & Construction Company, Ltd., last week resolutions were passed providing for the subdivision of the shares and for increasing the capital from £960,000 to £1,300,000. Sir J. Fortescue Flannery, Bart, M.P., M.I.C.E., who presided, said that the transition from war to peace conditions in their trade had been extraordinarily rapid. Trade had increased by leaps and bounds, and had increased in a way which forced them to recognise that they could not cope with the orders unless they provided special means for dealing with them. They had erected new works, enlarged some of the existing shops and provided new machine tools. The turnover in money in proportion to the turnover in manufactured tons was very greatly increased. There were several causes which made an increased capital necessary. In the first place, there were the increased charges for buildings and fixed plant; secondly, the increased cost per ton of manufactured cable; thirdly, the increased volume of orders; and, fourthly, the increased facilities of a financial character which their customers expected. The directors proposed to divide the £5 shares into five shares of £1, to increase the working capital by £400,000 in the form of 400,000 "B" 7½ per cent. cumulative preference shares.

They had fine business contracts both at home and abroad awaiting execution, and they looked forward to a satisfactory future. Legislation was now in contemplation, and he thought it would probably be carried out in connection with electric supply. There were also great developments of a scientific character—higher pressures, larger loads, longer distances for transmission and extension of the telephone system. Business in our Dominions across the seas and in foreign countries continued to expand, and they believed that the electrical industry had a fine future.

Sir T. O. Callender, J.P., managing director, who seconded the resolutions, said that he endorsed all the chairman had said as to the necessity of providing additional capital resources in view of the large business which they were carrying out, and the still larger business which in the near future they expected. In consequence of the great expansion of electrical distribution throughout the country, he looked forward to a prosperous career for the company.

The report of the directors of the English Electric Company, Ltd., for the year 1919 states that the balance to credit of profit and loss account (including certain undistributed profits of subsidiary companies at Jan. 1, 1919) is £410,835. Deducting debenture interest and trustees' fees (£23,943), expenses of debenture issue (£115,660), preliminary expenses (£17,385), amount transferred to capital reserve account (£100,000) and the dividend at rate of 6 per cent. per annum on the preference shares (£28,703), the balance is £125,144. The directors propose to pay a dividend on the ordinary shares at the rate of 8 per cent. per annum (absorbing £79,843) and to carry forward the balance of £45,302. The company is, for the time being, a holding one, deriving its profits in the main from dividends on shares from its subsidiary companies. It has always been, and still is, the intention of the directors to consolidate the different constituents into one manufacturing entity, but the process is slow, especially at present. During the greater part of the year the several works were occupied in the conversion of the plant from War conditions to those suitable for commercial requirements. As the company owns the whole of the shares of the Coventry Ordnance Works and the Phœnix Dynamo Manufacturing Company, the directors have been able to transfer from these companies sufficient of their undivided profits at Jan. 1, 1919, to permit of the writing-off of the whole of the discount on, and expenses of, the debenture issue, and of the preliminary expenses of the company as well as the setting aside of £100,000 to capital reserve. During the year, negotiations for the purchase of the Siemens Dynamo Works at Stafford were brought to a satisfactory conclusion, but as possession was obtained only at the beginning of December, no profits have been taken in from that source. Since the beginning of 1920, an opportunity has occurred for the disposal of the Scotstoun Works belonging to the Coventry Ordnance Company on satisfactory terms. The works now controlled and operated by the Company are as follows: Dick, Kerr Works Preston; Ordnance Works, Coventry; Phœnix Works, Bradford; Siemens Works, Stafford; and Willans Works, Rugby, and the products cover all classes of electrical and allied machinery. The moulders' strike has materially reduced output and its effects are still hampering production. The position of the Company's order book is good, and the directors hope that, given the absence of further labour disorganisation, satisfactory results will be realised. During the year Sir John A. F. Aspinall and Lord Meston joined the Board.

British Electric Transformer Co.

At recent meetings of the preference and ordinary shareholders of the British Electric Transformer Company, Ltd., resolutions were adopted, modifying the rights of the shareholders. Mr. A. F. Berry, who presided over the meetings, said that he did not think it was generally recognised to what an enormous extent the electrical industry had already developed. Although he had been actively engaged in the industry since boyhood, he was himself surprised recently to find how greatly it had grown, thanks mainly to the unceasing energy of the enthusiastic body of scientific and other workers connected with it. It was brought to his knowledge recently as chairman of the Electrical Development Association (an association recently formed by the various branches of the industry for the interchange of ideas between themselves and the many sections of the great community for which they laboured) that something approaching £150,000,000 sterling had been invested in the electrical industry. It was difficult indeed to over-exaggerate the importance of the electrical industry of Great Britain to this and other countries. It had been built up in pre-war years under very great difficulties, and was neither a hot-house plant nor a war creation. Their company was one of the few that had an almost unbroken record of successful effort since its inception up to, through, and since the war. To-day the manufacturing firms of the country of all kinds, from huge colliery, chemical and steel works, to the most humble factories, depended largely upon a supply of power through Berry transformers. Railways also, such as the L. & N.W. and the L. & S.W., had already electrified their London sections, and had called upon them to supply something of the order of 100,000 h.p. for that purpose. Who could place a limit on the demand for transformers when super-stations and main lines got busy with electrification? Wireless telegraphy, and all that it meant, was, of course, impossible without transformers, and the ever increasing demand for electricity supply generally was dependent primarily on transformers. The domestic demand for electricity for running the well-known vacuum cleaners, "Tricity" cookers, fires, kettles and various electrical appliances in the shape of domestic helps was developing at an unprecedented rate. That domestic demand was destined almost to overtake the industrial demand for electricity, and so double the demand for transformers. Shareholders who had electric light installed in home, office or factory, or could obtain it, would do well to pay a visit to the company's showrooms in Oxford-street, because they might rest assured that pleasant as those "Tricity" things were to look upon, they were being manufactured and purchased by the ten thousand by the trade, mainly because of their extraordinary utility. In the majority of cases shareholders had about equal proportions of the preference and ordinary shares on which they suggested paying 7 and 12½ per cent. respectively, and he hoped the time was not far distant when on the ordinary shares they might be able to pay something more. The company, during the war and since the armistice, had not earned so large a percentage of profit on its output as it did in the best pre-war times. They felt that if the electrical industry was to do its best and supply cheap electricity they must help to keep the first cost of machinery—which in modern times added appreciably to the cost per unit of electricity—down within the limits as reasonably low as possible. By selling as cheaply as possible they also enhanced their goodwill and developed their business in the best way possible. Quite a considerable section of their works extensions in the old days were paid for by the proceeds of the sales of some of his foreign patents. From the works so erected had been sent out to all parts of the world their products made as only the best British technical skill and artisanship could make things. Already he had had evidence from foreign buyers that their machinery, in common no doubt with the best British products of all engineering kinds, had stood up during the war to overload and other straining conditions in a way that had left the products of all other countries far behind. In other words, the Berry transformer alone withstood the heaviest strain. There were times when a certain amount of self-congratulation was needed, and he thought that the moment, when they were considering the question of raising further capital for the development of what was proving to be one of the best British electrical enterprises, was one of them. The result of their many years of specialised efforts were now manifest in the continually growing demand for their products.

Presiding over the ordinary meeting on Tuesday, Mr. Berry said that the profit for the past year was over 70 per cent. more than in 1918, but the issued capital had been increased by over 60 per cent., and he thought shareholders would agree that the position of the company was highly satisfactory. Of the available balance of £52,000 they proposed to pay away in dividends about one-half, and to strengthen the financial position of the company by retaining in the business over £23,000 of the balance. With regard to the ordinary shares, the directors again had the pleasure of recommending a 2½ per cent. bonus in addition to the 10 per cent. dividend. He hoped that when they got well into their post-war stride to do something better still for the ordinary shareholders, who had so willingly agreed to improve the fixed preference dividend. After referring to the new issue of capital, he said so far as could be seen, they would not require to issue any further shares for some time to come. The average yield to holders of equal quantities of preference and ordinary shares at the present rate of dividend was roughly 10 per cent.—even in these times a very acceptable one on such a good security.

New Companies.

BERRITE, LTD. (166,397).—Private company. Reg. April 14, capital £30,000 in £1 shares, to take over the business carried on by the Copal Varnish Company, Ltd., as dealers in insulating materials and compositions under the style of "Berrite," including the trade mark "Berrite." Solicitors: Janson, Cobb, Pearson & Company, 32, College-hill, E.C.

BOWER & TAYLOR, LTD. (166,193).—Private company. Reg. April 9, capital £5,000 in £1 shares, to take over the business of an automobile and electrical engineer carried on by J. A. Bower as "Motor and Electrical Industries." Reg. office: 7-8, Gt. Winchester-street, E.C.

BRITISH PLUGS, LTD, (166,340).—Private company. Reg. April 13, capital £500 in £1 shares, to carry on the business of makers of sparking plugs, &c. First directors are: D. F. Lintone and S. Jacobs. Reg. office: 86, Church-street, E.1.

F. BROWN, LTD. (166,093).—Reg. April 7, capital £30,000 in 15,000 8½ per cent. cumulative preference and 14,500 ordinary shares of £1 each and 10,000 employees' shares of 1s. each, to take over the business of engineers and manufacturers carried on as "F. Brown"; also to carry on the business of manufacturers of and dealers in optical, cinematograph, electrical, scientific and medical apparatus and instruments, &c. First directors are: F. Brown, A. Anderson and J. H. Clarke. Reg. office: Langley Works, Langley Court, Long Acre, W.C.

CHESTERFIELD TUBE COMPANY, LTD. (166,341).—Reg. April 13, capital £485,000 in 75,000 shares of £1 each and 1,440,000 shares of 5s. each, to carry on the business of manufacturers of steel and iron, tubes of wrought iron, steel or other metals, mechanical and electrical engineers, &c. First directors are: A. F. Nicol, C. C. Hatry, P. Haig-Thomas, G. Hooper, A. Mitchelson, H. W. Pelham-Clinton and W. A. Woodeson. Reg. office: 6, Austin Friars, E.C.

CORNHILL ENGINEERING COMPANY, LTD. (166,344).—Private company. Reg. April 13, capital £120,000 in £1 shares, to carry on the business of ship furnishers, mechanical and electric engineers, boiler makers, &c. Reg. office: 8, Cornhill, Liverpool.

DE MARTIS ACCUMULATORS, LTD. (165,685).—Private company. Reg. March 25, capital £200,000 in £1 shares (100,000 8 per cent. cumulative preference), to carry on the business of electrical engineers and contractors, suppliers of electricity, manufacturers of and dealers in railway, tramway, electric and other apparatus, &c. Reg. office: 70, Lombard-street, E.C.

DON ENGINEERING COMPANY, LTD (166,456). Private company. Reg. April 14, capital £200,000 in £1 shares, to take over the business of consulting, mechanical and electrical engineers, physical and scientific consultants, patentees, metallurgists, &c., and to adopt an agreement with Dr. A. M. Low. Solicitor: T. Outer, 17, Throgmorton-avenue, E.C.

DURRANTS ENGINEERS, LTD (165,780). Private company. Reg. March 27, capital £5,000 in £1 shares, to carry on the business of sanitary and electrical engineers, tool makers, &c. First directors are: A. E. Durrant and W. E. Durrant, both of Lowestoft.

A. MURRAY & COMPANY, LTD. (165,486).—Private company; reg. March 20, capital £4,000 in £1 shares, to take over the business of electrical, mechanical and motor engineers carried on by A. Murray, H. Morris and D. Murray at Liverpool. First directors are A. Murray (chairman), H. Morris, D. Murray, R. J. Hamilton, R. W. Anderson, and J. Connell. Reg. office, 15, Brasennose-road, Liverpool.

NORTH BOLIVIA POWER AND ESTATES, LTD. (165,657).—Private company. Reg. March 24, capital £1,000 in £1 shares, to carry on the business indicated by the title, and that of financiers, &c., and to adopt an agreement with E. F. Lamb and J. R. Leach. First directors are: E. F. Lamb and E. Devereux. Reg. office: 16, Dashwood House, E.C.2.

RUBERY, OWEN & COMPANY, LTD. (166,447). Reg. April 14. capital £1,000,000 in £1 shares, to carry on the business of constructional and mechanical engineers, manufacturers of and dealers in engineering machinery and motor cars and frames, &c. First directors are: A. E. Owen, G. H. Buckley, C. E. Partridge, C. Guy, A. F. Wilken, H. S. Price and W. S. Stambridge. Reg. offices: Boot-street, Darlaston, Staffs.

SHIPBUILDING AND ASSOCIATED INDUSTRIES. LTD. (166,427).—Capital £20,000,000 in £1 shares. to promote, organise, direct and finance shipbuilding, shipping, steel, armament, blast furnace, motor car, aircraft, mining, engineering, manufacturing and aliled or subsidiary undertakings and operations, and to carry on the business of shipbuilders and repairers, managers of shipping companies, electric and general engineers, founders, &c. First directors are: Sir George B. Hunter, T. E. Thirlaway and Earl Grey. Reg. office: 21, Russell-square, London, W.C.

J. E. SLACK, LTD. (166,227).—Private company. Reg. April 9, capital £30,000 in £1 shares, to carry on the business of manufacturers of and dealers in tubes, pipes, conduits, bends, flanges and accessories for tubes, &c. First directors are: J. E. Slack and A. H. Spearling. Reg. office: 60, Queen Victoria-street, E.C.

TALBOT-STEAD TUBE COMPANY, LTD. (166,219).—Reg. April 9, capital £500,000 in £1 shares, to take over the business of the Talbot-Stead Tube Company, Ltd., and to carry on the business of manufacturers of and dealers in steel and iron tubes, &c. First directors are: B. Joberns, Sir Edward T. Holden, W. J. Talbot and B. Perry. Reg. office: Green Lane, Walsall.

TELPHOS, LTD. (166,495).—Reg. April 15, capital £30,000 in 35,652 ordinary, 40,000 "A" preference and 44,348 "B" preference shares of 5s. each, to adopt an agreement with the Telephos Domestic and Street Lighting Company, Ltd., and the liquidator (H. H. Foster), for the acquisition of certain rights and property referred to therein. First directors are A. St. J. Cooke, Sir James Heath, Bt., F. W. Wright, A. E. Broadberry and J. H. Swinson. Reg. offices: 205-6-9, Salisbury House, E.C.

Prices of Metals, Chemicals, &c.

TUESDAY, April 20.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£111 0 0	—	£1 0 0
Electro Wirebars...	,,	£113 0 0	—	—
H.C. wire basis......	per lb.	1s. 3⅜d.	—	—
Sheet	,,	1s. 5½d.	—	¼d.
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8¾d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 11d.	—	⅜d.
Sheet, basis	,,	1s. 3¾d.	—	½d.
Wire, basis	,,	1s. 3¾d.	—	—
Iron—				
Cleveland Warrants	per ton	£10 7 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£48 10 0	—	—
Lead Pig—				
English	,,	£40 0 0	—	£2 0 0
Foreign or colonial	,,	37 0 0	—	£0 15 0
Tin—Ingot	,,	350 10 0	£5 10 0	—
Wire, basis	per lb.	0 4 5	2½d.	—

Salammoniac.—Per cwt. 105s.-100s.

Sulphur (Flowers).—Per ton £22.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £8 8s. 9d.

Copper Sulphate.—Per ton £48.

Boric Acid (Crystals).—Per ton £74.

Carbon Bisulphide.—Per ton £56.

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate—Per lb. 5½d.

Rubber.—Para fine, 2s. 3d.; plantation 1st. latex 2s. 2d. per lb.

Shellac.—T.N. Orange, 450s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd. and the rubber prices by W. T. Henley's Telegraphic Works Co., Ltd.

Forty Years Ago.

(THE ELECTRICIAN, APRIL 21, 1880.)

BOSTON. The Common Council of Boston will probably pass an ordinance regulating the erection of telephone and telegraph wire to prevent interference with the fire alarm telegraph.

NEW ELECTRIC INSTRUMENTS. Recent numbers of the "Comptes Rendus" contain accounts of two new instruments devised by M. Deprez. One is a galvanometer for measuring strong current of electricity, and one for continuously registering the total energy of a current.

THE CAVENDISH LABORATORY.—Lord Rayleigh's lectures on Elementary Electricity and Magnetism (experimental) will be delivered in the Cavendish Laboratory thrice a week this term. A fee of two guineas per term is now payable for the use of the laboratory, with instruction.

THE SOCIETY OF TELEGRAPH ENGINEERS.—On Wednesday, April 28, the following Papers will be read: "On the Resistance of Galvanometers," by Oliver Heaviside, associate; "On the Determination of the Position of Faults in a Cable when Two Exist at the Same Time," by Charles Hockin, M.A., member; "On Testing by Received Currents," by H. R. Kempe, member.

CLERK MAXWELL.—The memorial to the late Prof. Maxwell is to take the form of a bust and a collected edition of his scientific Papers. The Pitt Press has offered to publish a quarto edition of these in two volumes, and to supply 150 copies at prime cost for presentation to learned societies. The cost of these projects will be £700, but it is hoped to raise £900, in order to furnish an oil portrait by an approved artist. Messrs. Mortlock, of Cambridge, will receive subscriptions.

RAIN AT WILL.—General Ruggles, an American, has invented an ingenious notion for producing rainfall at pleasure, and, of course, has patented it. The plan consists in sending up a captive balloon into the air, supporting a platform which bears a supply of explosives, which are fired by means of an electric fuse when the balloon has reached a proper altitude. This is merely a practical application of the well-known fact that artillery practice or the cannonading in battles sometimes breaks the clouds and causes rain. It will probably only answer when the sky is cloudy, for we doubt very much if the explosions will be able to make clouds form in a clear sky. Even if it "squeezes" the clouds already in the sky, it will be serviceable, however, provided it does so effectively, otherwise the play will not be worth the candle. In any case, however, it is interesting to see how electricity is thus employed to produce artificial thunder and rain, a function which is performed in nature by the lightning flash.

AN ELECTRIC ALARM FOR LEVEL CROSSINGS.—These crossings where the roadway and railway cross each other at the ground level are usually attended by a watchman, who observes the signal of the coming train, and, closing the gates, prevents vehicles from passing. Accidents, however, have happened from this plan, owing to negligence on the part of the watchman, or failure of the signals to be observed by him. MM. Leblanc and Loiseau, two French engineers, have, therefore, devised an apparatus for effecting this purpose automatically. It consists of a key placed beside one rail of the line at a distance of a kilometre or two from the crossing, and a signalbox mounted on a post beside the crossing. These two parts are connected electrically through the rail and earth. When a train passes the key the first wheel presses in a lever, and completes a battery circuit, which causes a loud bell to ring in the signal box, and also displays a notice "Defense de passer" (no thoroughfare) on the front of the latter by drawing back a blind shutter. This notice is in black letters on a white glass ground, which by night can be illuminated by means of a candle or lamp. The bell continues to ring and the notice to show until the train has passed the crossing, when it actuates in a similar way a second lever key, which breaks the circuit and allows the apparatus to return to its original state of rest.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics":—"Trans-Continental Flying," a lecture by Captain Acland; Death of Professor Huntington; and Mr. F. W. Lanchester ("Pioneers of Aviation Series.")

"Cabinet Maker":—"The Activities of a Modern Veneer Factory"; "Early Nineteenth Century Chairs"; and "Construction of an Enclosed Washstand."

"Chemical Age":—"Fire Risks in Chemical Factories," by T. H. Cant, A.I.C.; "An Apparatus for Measuring the Vapour Tensions of Volatile Liquids," by A. V. C. Fenby, B.Sc.; and "Manufacture of Dyes and Fine Chemicals in America."

"The Fruit-Grower" (National Food Production and Transport number): "An Autographed Appeal from the Prime Minister"; "Food Supplies in Peace and War," a review of Sir Henry Rew's book; and "Horticultural Research at Cambridge University," by F. T. Brooks.

"Hardware Trade Journal": "Hardware for Spain"; "Jobbing Account Books"; and "Hints on Small Riveting."

"Ways and Means":—"Ramblings in Flanders," by the Editor; Sir George Paish on "The Budget"; and "Commercial Aspects of Aviation," by Major P. L. Holmes.

"Gas World":—"Gas in the Housing Schemes"; "Coal Conservation," a lecture by Sir Dugald Clerk; and "Gas in Pig Singeing."

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF
ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.
ESTABLISHED 1861.

No. 2,189. [Vol. LXXXIV. No. 18.] FRIDAY, APRIL 30, 1920. PRICE ONE SHILLING.
By Post, 1s. 1d. Abroad, 1s 2d.

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Notes.

An Engineering Senate.

THE proposal to establish a Senate for the engineering profession made by Mr. WORDINGHAM on another page of this issue contains in practical form an idea we have often put forward in THE ELECTRICIAN. It is necessary that engineers, no matter in what branch of the profession their particular occupation may be, should have some body which will represent their interests when questions both of external and internal policy have to be decided. It is only thus that we can stand four-square to movements which are likely to be detrimental to our well-being, and ensure that in every case where matters of pure and "political" engineering are discussed our views are represented in a way that will show that they have the whole weight of the profession behind them. Present-day politics are less influenced by considerations of the justice of a cause than by whom that cause is presented. If for no other reason then, engineers require some central body, because the legal, medical and other professions are already so combined.

The Desire for a Professional Status.

AT the present time there is no doubt an intense desire among engineers for an increase of both professional and political status. This desire has received expression in the Registration Bill recently drafted by the Institution of Civil Engineers. This Bill is, however, meeting with fierce opposition not only from without but from within the Institution for the reason that it is feared that corporate membership of that Institution will be a necessary preliminary to registration. Sir JOHN GRIFFITH has recently stated definitely that such is not the case. In any event, we agree with Mr. WORDINGHAM that this is work not for one Institution but for all in combination. If we understand Mr. WORDINGHAM rightly, his idea is that there should be two bodies, one to take care of the professional and the other of the political interests of engineers. We should like to see combination carried a step further and have one Central Body performing both functions.

The Senate and Co-ordination.

WITH that modification THE ELECTRICIAN has no hesitation in supporting Mr. WORDINGHAM's suggestion most warmly, nor have we any reason to fear that the support of electrical engineers as a whole will be lacking. The idea of a Senate has not yet received the official *imprimatur*, but it is interesting to note that Capt. RIALL SANKEY, who is a member of the Registration Committees of both the Institution of Civil and Mechanical Engineers, speaking at the Annual Dinner of the Institution of Mechanical Engineers, welcomed the proposal and pointed out the usefulness of such a body as an Engineering Senate in conducting examinations, arranging joint meetings and performing other similar functions. It is obvious, indeed, that from the point of view of both external and internal policy such a body could be of the very greatest use not only in co-ordinating the efforts of individual engineers and the numerous existing societies on the technical side, but in representing the profession on the political side. We hope, therefore, that its initiation will not long be delayed.

Water Power Resources

THE Committee recently appointed by the Board of Trade, under the chairmanship of Sir JOHN SNELL, to inquire into the water power resources of this country has published a unanimous interim report. We understand that a Bill is to be introduced to give legislative sanction to the Committee's recommendations. Though not so controversial a measure as the Electricity Supply Bill, the questions involved will undoubtedly trespass on vested interests, and the Bill is therefore certain to be the subject of criticism. Nevertheless, economy of water, which includes its right use, is as important as the conservation of coal supplies. The increasing cost and dwindling amount of the latter must cause our manufacturers to turn to other sources of power, and there are no doubt places where water power can be developed at a cost fairly comparable with that of a modern steam station. But even though water may not often be the cheapest method of producing electricity, it is one which in the present state of our resources we cannot afford to overlook. Besides recommending a survey of the domestic supplies of water it is also suggested that steps should be taken to increase the potable supplies for traders requiring water in bulk, that rivers should be conserved to assist in the development of capital generating stations, and that a central water authority should be formed to deal with the water supplies on a national basis. This is the right policy. Water, no less than electricity, has ceased to be a parochial and has become a national question.

The Inevitable Sequel.

The resignations of Mr. S. G. Kimber, Mayor and Chairman of the Southampton Electricity Committee, and of Mr. Harry Ellis, the Borough Electrical Engineer, are the inevitable sequel of the settlement of the recent strike at the Electricity Works in that town. The genesis of the dispute and its subsequent developments were detailed in our last issue and need not be recapitulated. To secure a temporary peace (for trouble is sure to recur) the Town Council submitted to the pressure of a threat of a general strike and re-instated the wrong-doers at the expense of those who had worked indefatigably to provide the town with light and power. There is no atom of excuse for this procedure and the Town Council comes out of the affair very badly. But their punishment will follow, and while the Electrical Trades Union and the other bodies representing labour interests in Southampton have scored a victory on this occasion it is likely to be one of those victories in which the winners suffer as much as the losers. There must be some end to this holding the public up to ransom, and that end must either be a realisation by the public of their power, and an exercise of that power over a recalcitrant minority working to undermine the body politic—or revolution. In either case the Trades Unions will suffer. The time has come for those bodies to put their houses in order before they fall about their ears and for the community at large to resist the ever-growing demands which are advanced, not to redress legitimate grievances, but to stir up strife.

Riding for a Fall.

There is another lesson in the Southampton affair for Trade Union officials. According to Mr. Ellis the members of the E.T.U. working in the station had no complaint, but were stampeded by the local officials without orders from the central authority. This lack of discipline is growing in Trade Union organisations. For their own good, and there is a great deal of good in them as everyone will admit, this must be checked or disaster can be the only result. It is the bounden duty of the more moderate minded members to take a greater part in the administration of these bodies, and for the working methods to be altered so that a possibility of the whole machine being wrecked by a revolutionary majority is prevented. The Southampton dispute is a case where a strike should never have been allowed. The whole point at issue was a domestic one between two Unions, and should have been settled by arbitration. The behaviour of the E.T.U. can only be likened to that of a bad-tempered child, which will in due course be followed by the punishment meted out to those pests of the nursery.

Tramway Troubles.

The same high and mighty attitude is being exhibited in the negotiations about wages now taking place in the tramways industry. Because you are strong it is not always wise to show it, and in this particular case it is really very foolish. As is well known, a large number of the tramway undertakings of this country are privately-owned and are therefore closely concerned with the problem of making receipts exceed expenditure, if only by a small amount. If the position in municipally-owned undertakings is not so serious it is at least desirable that they should not receive rate-aid if only for the benefit of the inhabitants of the town concerned, the majority of whom are included in the classes which Trade Unions are supposed to represent. It therefore follows that the amount of increase that can safely be granted depends in the first place on the financial condition of the undertaking.

The Inequity of a National Settlement.

This fundamental fact is either not realised, or has been conveniently forgotten, by the Transport Workers' Federation. In discussing the wages question they demand a national settlement on an equal basis for all workers. The National Council has, however, discovered that such an arrangement is hardly possible of attainment and have referred the whole question back to the seven District Councils in the hope that local settlements will thus be arranged. If the men's claims are based on the increased cost of living there is much to be said for local settlement. It is obviously less expensive and less arduous for a tramwayman to live in, say, Alloa or Burton-on-Trent than in London or Manchester. Although an agreement on these lines has been arrived at in South Wales and in the Midlands, the solution is not generally popular with the men, and at Swansea a strike has been declared to show their resentment, though with unusual consideration they have apologised to the public for the inconvenience they are causing. It must be admitted that the negotiations have not been well managed. The men were at first led to believe they would receive an all-round increase of 10s. per week, and it was not until the smaller undertakings protested their inability to pay such an amount that a district settlement was suggested. The result is that further trouble may be expected.

Nitrates from the Air.

When war broke out little had been done in this country to develop the various processes for obtaining nitrates from the atmosphere. How important this question is, not only for our national welfare but for the progress of electrical engineering and electro-chemistry, is sufficiently obvious from an unbiased persual of the report of the Nitrogen Products Committee. The work of that Committee was, however, by no means solely theoretical, and a good deal of preliminary work was done not only in investigating the details of the various processes but in the establishment of a factory for nitrate production in this country. Very wisely this site, which is at Billingham-on-Tees, and the stores upon it, have been disposed of to a syndicate comprising Messrs. Brunner, Mond & Company and the Explosives Trades, Ltd. Although little has been done in the way of building operations, designs had been worked out, and the capital required for carrying out the operations on the original scale will be about £5,000,000. The process usually known as the Haber process, though it was invented by an Englishman named Le Rossignol, will be used. This process depends on causing nitrogen and hydrogen to combine at a high temperature and under pressure to form ammonia. From every point of view it is highly desirable that a factory of this kind should be established in this country. Nitrates in one form or another are as essential to a human being as bread. Indeed, without them he could have little or no bread. That being so the less we depend on other countries for our supplies the better.

War Stores and the Peak Load.

The methods employed in disposing of the enormous stocks of war stores left on our hands at the signing of the armistice have not been a shining example of what Government administration should be. So little successful have they been and so slow the sale of the material, that in order to ensure the distribution of the articles within a reasonable time it has been necessary to call in private enterprise on at least one historic occasion. The success of that experiment has apparently led to its repetition with the result that the Aircraft Disposal Company have taken over for sale a very large quantity of aeroplane stores and will dispose of them under a contract which will be equally advantageous both to themselves and to the Government. There will be, however, no attempt to use the greater part of these stores for aeronautical work. As Mr. F. Handley Page pointed out on Friday last, propellers will be used for hat stands, bracing wires for bedsteads and under-carriages as caravan bodies. Further, the 200 h.p. Sunbeam "Aero" engine with its gearing removed can be run efficiently at a lower speed to drive electric lighting plant. We commend the idea to engineers of small stations in difficulties with their peak load, as these engines are now going cheap. It is probable, however, that a good many of the engines will suffer no such sea change, but will find their way to the United States for employment on the aeroplanes which are now being built in large numbers in that country for civil purposes. An American engineer recently informed us that nothing came up to the British aero engine for design and reliability. The destination of many of the engines purchased under this contract will prove the truth of that remark.

Foundations of Production.

In the special issue of The Electrician which appears to-day we break new ground. In the past we have published issues dealing with the application of electricity to more or less specialised industries and have thus been able to show how the employment of this form of drive has increased and how the interesting technical problems which have arisen owing to various developments have been met and solved.

Our object in to-day's issue is rather different. The electrical industry has reached a stage in its development when it can with equal profit contemplate both the past and the future. From the success no less than from the failures of the former it can add to its experience. It has done well in the past, but it might have done better and the problem arises how is it to accelerate its rate of progress.

Some Essentials.

The popular solution for doing this is increased production. To achieve this works must be planned, processes designed and the various operations and details of operations so thought out that everyone from the highest to the lowest is working for the good of the whole industrial machine in the best possible way.

Now all this, though undoubtedly true, is to some extent idealism. Before we can begin to manufacture on those lines a good deal of preliminary work will have to be done in the same way that before the township is built the primeval forest has to be cleared away.

Labour Questions.

The war has taught us some of the things that will have to be done. As Mr. Benn truly says, "we shall never return to the old relative status of master and man, which was the basis upon which our factories and our business and our trading concerns generally were founded." The worker is now better educated than ever he was. He is more of a man and less of a machine. This is all to the good, but it means a change of outlook.

The worker, then, is our first problem. He must be taught to see that a change in his methods is necessary not only for the good of the industry in which he is working, but also for his own good. To effect this he must be led rather than driven along the road by those who can appreciate and sympathise with his difficulties. Mr. Fleming and his colleagues indicate the lines upon which this may be done. An educated man doing congenial work is a contented man. But discontent is bred by monotonous, uncongenial labour, for everyone feels that they could be doing something better than that. Every worker, worth his salt now-a-days, and the others are not worth considering, needs proper "opportunities for self-development and self-expression and for a share in the control of conditions of work." That is a demand which cannot be denied. It cannot be met by the provision of canteens or the establishment of social clubs, but only by a determination really to understand what all this unrest means. Unrest is not Bolshevism, but something a good deal finer, but all the same it is grit in the machine and must be removed.

Cheap Manufacture.

After the labour problem, the next most important thing to decide is how to manufacture cheaply in order to sell cheaply. The two things are more closely allied than is sometimes thought, and must be considered together. Neither can the electrical industry be divorced from the other industries of the country, for what affects one is also reflected by the others. Manufacturing methods must, therefore, be considered to determine how they can be improved and what we mean when we talk about mass production. "Mass production," says Mr. Allingham, "is manufacturing in such large quantities that the plant is laid out in the correct balance and preferably in sequence, so that the work may pass from operation to operation consecutively. In general, hand in hand with mass production goes the special designing of the plant to carry out each operation in the most economical way and machines are not changed over from one type of job to another, but are permanently set up for one class of operation only."

Mass Production not a General Solution.

That is an ideal which requires a good deal of trouble to reach, and is obviously not applicable and should not be attempted by manufacturers dealing in certain classes of goods. But it contains the underlying principle which we have laid down above.

Selling a Corollary to Production.

It is obvious, however, that production without selling is no use. Indeed, the latter is as much if not more an essential of our future success than the former, and as Mr. Beauchamp rightly points out, one of our first duties must be the organisation of a proper selling campaign, with all sections of the industry working together and a determination to sell not just as much as we think the public will take, but all that we can produce. Mr. Watson's article is sufficient to show the great demand at present existing for electrical energy, all of which means an increasing demand for electrical apparatus. The demand can be stimulated by a reduction in present prices and that reduction in prices can only be achieved by improved methods.

With these considerations before us and a determination that there shall be no slackening of effort, there is no reason why the progress of the electrical industry should not be as outstanding in the future as it has been in the past.

The Arrangements for the Week will be found on p. 503.

The Organisation of the Electrical Industry.

By G. H. WORDINGHAM, C.B.E.

We speak of the Electrical Industry, but if asked to define it our task is a difficult one, for it is as complex as Engineering itself. We may discern the main divisions of purely professional, manufacturing and commercial, and these may be subdivided into heavy and light according to the class of work dealt with. These branches thus broadly distinguished, however, are by no means sharply defined and interlace with one another, while each has many ramifications of its own. Thus, while ordinarily the purely professional branch is considered to be represented chiefly by the consultant, it must surely be allowed that the chief designers in the country are in the same category even though their work is usually devoted exclusively to the needs of the manufacturer. Again, the best commercial engineers have of necessity a good professional training and some manufacturing experience. Though professors of engineering primarily belong to the great teaching profession, many of them are engineers first and teachers after, and teaching of electrical engineering is recognised by the Council as qualifying a man for membership of the Institution of Electrical Engineers.

The Status of the Electrical Engineer.

In considering the organisation of this heterogeneous mass we must recognise certain broad principles. Every man to be recognised as an electrical engineer must have some definite minimum amount of professional training. This may vary in its nature between wide limits, but there must be the foundation of a liberal education, such as is given at a public school, and on this must be superimposed adequate scientific and technical training, crowned by experience in works or the office of a practising engineer. Each man as an individual, therefore, must acquire a definite professional status; having acquired it, there should be some hall mark by which he may be known.

The first thing to determine then is: who is to make the assay and who is to give the imprint. This at once raises a question of immediate practical import. The Institution of Civil Engineers is promoting a Bill in Parliament under which they seek to be the authority for registering a man as a civil engineer and, inasmuch as they claim that civil engineering embraces every known form of engineering (and every form now unknown but which may eventually be created or developed) it is clear that electrical engineering comes quite definitely within the purview of the Bill. Obviously the Institution of Electrical Engineers cannot allow its functions to be usurped by any other Institution of however high standing, and the Bill will have to be amended. But the principle of registration, apart from the Bill, calls for consideration. It means that only an engineer, registered as such, can practise the profession without incurring penalties. Suppose the Institution of Civil Engineers could be persuaded to restrict the term "civil engineer" to those engaged on what is popularly known as civil engineering, viz., road making, harbour construction and similar work, leaving electrical, mechanical, mining, chemical and other subdivisions of civil engineering to attend to their own registration. Would this be desirable? Emphatically not. In the first place, the difficulty which the Institution of Civil Engineers' Council professes of limiting the term "civil engineer" is a real one and would be just as difficult for the Institution of Electrical Engineers in respect of electrical engineers and for the Institution of Mechanical Engineers in respect of mechanical engineers. Secondly, it means division of engineering forces, and, with the utmost solidarity, the task of obtaining proper recognition of the engineering profession is hard enough. Let us all agree to the wide definition put forward by the Institution of Civil Engineers and jealously press our claim to be Civil Engineers in all the breadth of the words of the grand old Charter, but let us press no less strongly that the changes wrought by time shall be recognised, and that the daughters of the Institution of Civil Engineers, the Institutions of Electrical and Mechanical Engineers and some others shall look after their own children, and be the ones to certify that they are members of the family or clan. The solution of our present difficulties and disputes would seem to be: Recognise broad divisions of civil engineering as having grown up and establish an Engineering Council, or Tribunal or Senate, call it what you will, and let each branch be represented thereon on equal terms.

What the Senate Would Do.

Under such a scheme, the acquisition of engineering status would be an individual matter proper to each engineer, and would be obtained from the general engineering senate. There would be the same *standard* of training and performance for all and many subjects would be common to all branches. First, there would be the broad liberal education on the lines of that given in a recognised public school. Next the general grounding of mathematics, mechanics, physics and chemistry, without which no one can claim to be an engineer. After this, specialisation would begin, and the subjects chosen would be appropriate for the particular branch in which the young engineer intended to practise.

Too much sub-division would be impracticable, but the following broad classification is suggested: (1) Civil engineer in its restricted sense, (2) Mechanical, (3) Electrical, (4) Metallurgical (5) Chemical, (6) Mining and (7) Naval Architect. All might be designated Civil Engineer with a qualifying parenthesis, except those in sub-division 1., following the analogy of naval practice, *e.g.*, Lieutenant (T). Thus the above would be referred to as Civil Engineer, Civil Engineer (M), Civil Engineer (E), Civil Engineer (Chem), Civil Engineer (Met), Civil Engineer (Mi), Civil Engineer (N). Each of these branches has already a thoroughly representative Institution, and that Institution should be given the task of reconciling all subsidiary and auxiliary institutions or societies within its branch of engineering and for arranging for the representation of that branch on the Engineering Senate.

It cannot be denied that on the roll of every one of the Institutions there are the names of those who are not up to the standard indicated and who, if they were now entering the profession, could not claim to have had the requisite training. It would be impossible on the grounds of equity or expediency to exclude these existing members from the proposed new register, and, in the first instance, all those who have been admitted to the several Institutions should be registered without question as Civil Engineers in one or other branch. All great reforms of the kind adumbrated must be effected gradually and the desired standard be an ideal to be worked to and realised as soon as possible without injury to those at present practising. In one generation the change would be effected and the status of engineering raised and firmly established.

Proposed I.E.E. Charter.

Reference may be permitted to the scheme for a Charter for the Institution of Electrical Engineers which was put before the members of that Institution last year by the author. No further steps have been taken in the matter because it was felt that the proposals were profoundly affected by the Bill introduced by the Institution of Civil Engineers, and until this was dealt with one way or another action would be inexpedient. At the time the author's proposals were put forward, it seemed hopeless to attempt any general action in regard to all branches of engineering, but the Bill has raised such a storm of opposition that all parties have been awakened and, difficult though it may be, it would seem quite within the realm of possibility to bring all parties together. If so, this is obviously better than any scheme for registering or certifying electrical engineers by themselves. The main features of the proposal for a Charter, however, are in no way affected, the only difference being that instead of acquiring their status as Electrical Engineers through what was designated the Professional Council they would acquire it through the Engineering Senate. Space does not allow of a recapitulation of the outlines of the Charter scheme, but those interested will find it set out in full in the Journal of the Institution of Electrical Engineers for April, 1919.* Suffice it to say that the scheme aimed at bringing together all branches of electrical engineering, heavy and light, and at finding a place in a complete scheme for the important trade organisations which have grown up. The whole electrical industry was to be represented by a Grand Council, and this Grand Council would afford the opportunity of bringing together the whole electrical industry and establish the body which would send representatives to the Engineering Senate. These representatives would necessarily be fully qualified Civil Engineers (E), but they would be in full touch with every branch of the industry through the Grand Council of the Institution of Electrical Engineers. The new suggestions affecting engineers as a whole, therefore strengthen rather than weaken the scheme.

THE POSITION OF SEMI-QUALIFIED MEN.

The complexity of the electrical industry has already been referred to, and it must be admitted that many of those who take up these branches in the future can hardly claim to be regarded as Civil Engineers (E), but in some cases their scientific, as distinguished from their engineering attainments, are of a high order, while in other cases their work which is chiefly commercial, is so intermingled with engineering that some place must be found for them in the general scheme of organisation. A similar position, though perhaps not so accentuated, arises in connection with other branches of civil engineering, and it would seem that the best way of dealing with the matter would be to admit these individuals to the respective *Institutions* as members in some grade, whether that of Associate Member, Graduate or Associate of those Institutions. This would confer a certain status on the members, but necessarily inferior to that of a civil engineer registered by the Senate. This would be of advantage to the individuals and would at the same time strengthen the Institution concerned by knitting together all the individuals concerned in the industry, and ensuring that no branch was left out by itself.

Briefly to summarise what has been said, every individual whose training warranted it would be registered by the Engineering Senate as a Civil Engineer belonging to one or more specified branches; other individuals whose training did not qualify them as engineers, but whose occupation brought them into intimate relation with a branch of the engineering industry would acquire a certain status by membership in one grade or another of the Institution representing that branch. In the electrical industry all the various associations, trade and otherwise, such as the I.M.E.A., the Association of Power Companies, the Provincial Supply Companies, the London Companies, the B.E.A.M.A., the C.M.A., and others would be banded together under the auspices of the Institution of Electrical Engineers which would be governed by a Grand Council working under a Charter to be obtained. This scheme would appear to form a consistent whole, and if similar action were taken by the branches of engineering other than electrical, there would be a large mass of organised engineering opinion which it would be hard to withstand.

THE PROTECTION OF MATERIAL INTERESTS.

So far as the material, as distinguished from the professional and industrial interests, of individuals are concerned there is room for a protective association devoted entirely to such material interests. Obviously, such a body should follow the main idea of the Engineering Senate, and should provide for individuals engaged in every branch of civil engineering. This the Society of Technical Engineers already formed aims at doing, and every possible effort should be made to link this body up with the existing professional Institutions. Membership of the S.T.E. should be dependent upon the acquisition of a definite status. Room should be found for every registered civil engineer and also for that large body of individuals, who, while not eligible for registration by the Senate, are nevertheless accepted as members in one grade or another by the several Institutions. The S.T.E. itself is so organised that it is subdivided on a two-fold basis, viz., Territorial, and by Sections which are defined by reference to the branch of engineering practised. This double subdivision should prove the solution of many difficulties which are met with in organising on a single basis either territorial or vocational, and it should be possible to find some means of embodying such bodies as the Electrical Power Engineers' Association which are devoted to a specific sub-section of engineering without destroying their identity, while retaining the solidarity of the larger society.

Turning from the organisation of individuals to that of industrial concerns more difficult problems are encountered, because trade combinations are based upon information which is essentially confidential, and known only to the parties immediately concerned. On broad lines, large single trusts, as commonly operated, are usually opposed to the public interest and often have in themselves the elements of self-destruction. On the other hand, large combinations, if not oppressively worked, but directed on broad and enlightened lines, are beneficial to all concerned. They enable production to be cheapened, selling to be organised on economical and comprehensive lines, and large foreign contracts to be effectively dealt with, thus helping on the vital work of export. Some of these advantages can be realised by the association of smaller firms with one another, each agreeing to take a certain portion of the work secured by the combination as a whole. In this way, mass production can be realised and the individuality of the smaller firms retained. It is difficult to over-value the advantages of individual attention and individual initiative, and these combinations of smaller firms are likely to be at least as prosperous as a very large single undertaking if they, like the others, be worked on broad and enlightened lines. The great danger of the combination of separate firms lies in the inherent tendency in human nature to suspicion and jealousy, and it is chiefly in the overcoming of this tendency that success lies.

THE NEW ELECTRICITY SUPPLY INDUSTRY.

The organisation of the electric supply industry is on the knees of the gods in the shape of the Commissioners. Fortunately these have been so chosen as to command the fullest respect and confidence of the industry, but their task is a gigantic one. Many supply schemes are in preparation, and it may be hoped that within the next year or two the general outline of the way in which the country is to be divided up, and the broad lines on which each area will be dealt with, will be settled. Much more than this, however, will be necessary before the new schemes can be in actual being, and a vast amount of work lies before the Commissioners in other directions. Research in regard to the plant, and more especially the switching and other control gear necessitated by the high pressures that will be necessary, calls urgently for attention. Revision of the regulations now in force which were promulgated by the Board of Trade will have to be undertaken. Some measure of control over the installations which are to utilise the "cheap and abundant supply" should be set up in the interests of consumers, of supply authorities and of the contractors who erect the installations. It may be hoped that some testing authority on the lines of a National Electric Proving House will be established having the countenance of the Commissioners, and in many other directions organisation, actively carried out, is necessary in the best interests of the industry. For example, it would be of immense service if some central exchange could be set up whereby generating plant, boilers and switchgear, which had become too small for an undertaking could be made available for others which were in an earlier stage of development; such an exchange could with advantage arrange for a careful inspection and test of the plant before it was received, so that buyers might know what to expect and, while thus affording an indication of the quality of the plant offered, the exchange could eliminate the profits of the merchant and bring together directly those engaged in the industry. It is not suggested that this body should be under Government control; it might well be co-operative, possibly under the guidance of the Electrical Development Association.

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* *See* THE ELECTRICIAN, Vol. LXXXII., p. 630.

The Popularisation of Electrical Methods.

The mention of this Association naturally brings up the question of popularising electrical methods, plant and appliances. The E.D.A. is an active body run on excellent lines, and every branch of the industry concerned is represented on its Council. Provided that adequate funds be forthcoming, its field of usefulness is practically unlimited, and it should be a potent force in furthering electrical interests. It would help the cheapening of supply greatly if it could bring home to the manufacturer the vital importance of the standardisation of the articles of domestic use, and the component parts of the installations to which they are connected. The members of the British Engineering Standards Association have devoted much time, attention and expert knowledge to this work, but their efforts are largely discounted by the extreme difficulty experienced by the B.E.A.M.A. in getting manufacturers to sink their individual interests, and when, after much toil, standardisation is accomplished by the B.E.S.A., it is robbed of a great deal of its value by the apathy of manufacturers in putting forward, and of purchasers in demanding, the standardised articles.

The standardisation of domestic appliances might with great advantage be carried a good deal further than has yet been attempted. Apart from the ordinary accessories used in connection with the wiring of domestic installations, it would be specially beneficial in connection with the parts of heating and cooking appliances. Unless and until these are designed so that the parts which are liable to deterioration with use can be readily renewed with the same ease as a length of rubber gas piping, electric heating and cooking will be handicapped in competing with the simpler and cheaper but inferior gas appliances.

The Organisation of the Standardisation.

The organisation for the actual work of standardisation already exists in the British Engineering Standards Association, and it would be difficult to suggest any improvement in regard to the way in which the work of this very active body is carried on. The extent of its usefulness is necessarily governed to a large extent by the funds available, more especially in regard to the extremely important work which has been initiated overseas, and which is probably little known so far to those outside the Association. All firms engaged in the industry benefit in a greater or less degree from the work of the B.E.S.A., and all should contribute to its funds. The fairest way would be a levy on all manufacturers, proportioned to the scale of their operations.

Research.

Large manufacturers will probably always find it advantageous to establish and carry on their own research laboratories, but there is a wide field for collective research in connection with which all manufacturers engaged in a particular branch are interested. The organisation of such collective research has occupied the very close attention of the Institution of Electrical Engineers and of the B.E.A.M.A. for the last five or six years. The electrical industry differs from most of those with which the Department of Scientific Research, which administers the funds voted by the Government for research, has had to deal on account of its complexity and of the fact that research has always occupied a prominent place in the industry. The main difficulty has been to reconcile the form of constitution insisted on by the Department with the various bodies interested so as to ensure that all the expert knowledge could be drawn upon by the Association. The difficulties now appear to be practically surmounted, and there is every hope that the Electrical Research Committee may become an Approved Association at an early date. Such approval carries with it very material advantages, and will enable the large amount of spade work which has already been done to produce fruit to the great benefit of the industry.

Present Position and Future of Electricity Supply.

By S. J. WATSON, M.Inst.C.E., M.I.E.E.
(Borough Electrical Engineer, Bury.)

One of the many lessons impressed upon us during the war, was that if we wish to obtain the most efficient results in connection with the manufacture of any commodity, it is necessary to produce in large quantities. When all important industrial concerns became certified undertakings, one of the first steps taken by the Ministry of Munitions was to arrange that the existing equipment of works and factories should be employed on work which necessitated the least alteration to adapt it to a certain purpose. In some cases, additional tools had to be provided to ensure a balance in the various processes, and in others considerable extensions, both to buildings and equipment, were carried out. When it was realised that even by making the fullest use of existing resources, the requirements of the country could not be met, new works were provided in suitable localities to make up the shortage. As a result, the capacity of the country to produce munitions was enormously increased, and as the quantity increased, so was the cost reduced.

Electricity supply undertakings played no insignificant part in these proceedings, by providing the power requirements of industry, and in a large number of cases special assistance was rendered by the Ministry to accelerate the completion of extensions. Largely, as a result of these additional demands, the plant capacity of supply undertakings in this country increased from about 1,250,000 kw. in 1914 to 2,500,000 kw. in 1919, with a corresponding increase in the yearly output from 2,000,000,000 units in 1914 to a rate equal to not less than 4,500,000,000 units per annum during the months immediately preceding November, 1918.

The position at this stage may be explained by stating that in consequence of the restrictions on the import of certain raw materials, and on the export of finished articles, various industries such as those engaged on the production of paper, furniture, building materials, certain textile trades, &c., had largely curtailed their output and consequently their demand on supply undertakings. Any plant released in this way had been promptly utilised by industries engaged on more vital work, and later many plants had to be extended to meet additional requirements in this direction.

For a short period following the armistice, the output remained more or less stationary, but as stocks of war materials accumulated, and it became apparent that hostilities had really ceased, a very serious reduction took place in the demand for power, due to the closing down of the manufacturing plants solely operated for war purposes. As this period of slump was accompanied by a considerable increase in costs due to an advance in the price of fuel, and to wages awards, the immediate outlook was not particularly promising.

Present Position of Supply Undertakings.

The restrictions in regard to imports and exports continued for some time after the armistice, and there was consequently a transition period during which the production of munitions was seriously curtailed or entirely stopped, and the peace-time industries could not be re-established. As the restrictions were removed the peace-time industries reverted to their pre-war demands, and many of those engaged on munitions adapted their plant to the manufacture of articles or materials required to make good the world shortage occasioned by the war; additional industries also started to assist in this urgent and important work. The result is that in many areas supply undertakings are being overwhelmed with applications for power which, with the inadequate resources at their disposal, it is quite impossible to meet. Although every endeavour is being made to increase the capacity of plants, considerable delay, inconvenience and loss must occur until an equilibrium is established between supply and demand. It is most unfortunate that an unlimited supply of power is not at present available in industrial districts, in view of the urgent necessity to attain the maximum possible production of articles or material particularly for export purposes.

Although the increase in the output of undertakings during the war is equal to 125 per cent., the fact may be mentioned that this only represents an addition of slightly over 16 per cent. per annum. The progress made by many undertakings during the years immediately prior to the war was considerably more than this. It is not unreasonable, therefore, to assume that the increase would have been attained in any case. Some undertakings have undoubtedly developed at a much quicker rate than was anticipated, while others have had to mark time. It is difficult to estimate the amount of plant now actually on order or decided on; but it will probably reach, if it does not exceed, 1,000,000 kw., and this capacity will be put to effective use as soon as installed. With the completion of these schemes, say in 1921, the total capacity of plant will be about 3,500,000 kw., and the annual output 6,500,000,000 units. The estimated horse-power hours used by all the industrial steam-power plants in Great Britain, excluding Public Utility Undertakings, may be taken as the equivalent of 12,500 million units per annum. The output of all the supply undertakings in 1921 will therefore be equal to about one-third of the requirements of the manufacturing concerns already established.

Points for the Future.

In connection with future progress, say for 20 years beyond 1921, there are four important potential demands to take into consideration, viz.: (1) Industrial power; (2) Railways and transport; (3) Chemical and electro-metallurgy; (4) Domestic supplies. If we are to maintain a leading position amongst the nations of the world, there must be a radical change in many manufacturing processes. The quantity and the value of the goods produced per annum per person employed must be immensely increased. This can only be done by the extended application of power. To make the industries of this country comparable with those of certain other nations, the power required per employee per annum should be increased from two to fourfold. In other words, the requirements of industrial concerns now furnished by steam plants supplying power of the equivalent of 12,500 million units should be increased at least threefold, say, to 37,500 million units per annum.

Signs are not wanting that railway electrification will make rapid progress within the next few years. It has been estimated that if electrical energy is substituted for the work done by the 25,000 locomotives employed by all the railway companies, at least 7,000 million units per annum will be used for this purpose. When improved travelling facilities are arranged, and certain other means constructed for the transport of goods and merchandise, this amount should reach 10,000 millions per annum.

A largely increased demand should be required by the chemical industry, and for electro-metallurgy, as the many processes previously carried out abroad or initiated recently in this country are further developed. It is particularly important to bear in mind the increasing demand for the production of metals in electrical furnaces. We may assume an ultimate demand of 1½ millions kw. for these purposes, and as the load-factor is admittedly high the consumption would be 10,000 million units per annum.

Requirements of Domestic Consumers.

There still remains the exceedingly difficult question of estimating the ultimate requirements of domestic consumers for light, heat and power. The matter is of special importance at the present time by reason of the many housing schemes under consideration all over the country. It is doubtful whether the total units supplied for lighting purposes to all classes of premises at present exceeds 500 million units per annum, and as the majority of large consumers are already supplied, it is probable that if all lighting is eventually done with lamps of present-day efficiency, the total increase will not exceed 2,000 million units per annum.

The domestic consumption of fuel is 35 million tons per annum, equal to about one-fifth of the total used in the country; distributed among some 10 million houses. Substantially the whole of this fuel is used in open grates for heating rooms, boiling water or cooking. The coal consumed per hour by open grates naturally varies between very wide limits, depending on the purpose for which it is used and the season of the year. During cold weather or when carrying out cooking operations, it may reach 4 lbs. per grate per hour, but when the fire is partially banked in warmer weather, or between meals, it may be as low as 1 lb. per hour. The average quantity of fuel used per house per annum is 3·5 tons, say 7,840 lbs. Allowing 1·5 lbs. per grate per hour, as the average winter and summer, this represents the use of one fire for 5,226 hours, say 14 hours per day. In houses occupied by the poor, the minimum annual consumption is probably as low as 1·5 tons per annum, whereas in large houses it is enormously higher.

If the whole of the 35 million tons used per annum for domestic consumption was converted into electrical energy, and distributed in this form, the number of units would be approximately 40,000 millions per annum. There is at least a doubt whether electrical energy will ever be used entirely to provide domestic heat. On the other hand, it seems certain that the use of crude coal as the principal heating medium will not be allowed to continue. A possible solution may be found in the use of a smokeless fuel resulting from crude coal with many of the by-products extracted, or by the use of low candle-power gas for certain domestic purposes, and electricity for the balance. We may roughly divide up the quantity of heat used in houses into two parts, *i.e.*, that required for purposes closely akin to industry, such as cooking, water heating, &c., and that required to maintain the occupied rooms at a comfortable temperature. In small houses both duties are combined. If we assume an equal division of the fuel consumed between these two purposes and accept a further assumption that only one-half will be accomplished electrically, the demand may reach 20,000 million units per annum. It will probably take a longer time to solve this question than any other, not so much on economic grounds, but because it necessitates a change in the habits of the people, and at the same time involves a heavy capital expenditure on the substitution of apparatus of a different character for existing firegrates, cooking ranges, heating tanks and cylinders. The large number of new houses to be erected, of which many will be mainly or entirely equipped for using electricity for all purposes, should stimulate developments in this direction.

The Industry in Twenty Years.

Summarising the foregoing remarks, the electricity supply industry at the end of twenty years may be called upon to deal with the following annual output in addition to that at present supplied :—

	Units per annum.
Industrial power	37,500,000,000
Railways and transport	10,000,000,000
Chemical and electro-metallurgy	10,000,000,000
Light	2,000,000,000
Domestic supply	20,000,000,000
	79,500,000,000

Owing to the diversity in the demands we may safely assume that the power stations dealing with this output will be working under conditions yielding a load-factor of 60 per cent., the maximum load will, therefore, be about 15 million killowatts, with an installed capacity of nearly 20 million killowatts. During the period 1921 to 1941 the requirements of new plant for power stations should, therefore, reach an average of 1 million kilowatts per annum. In passing, the fact may be noted that although an increase from 6,500 million units per annum to 79,500 million units per annum appears almost unattainable even in 20 years, it is really only at the very modest rate of 13 per cent. per annum. The increase in the earlier years will exceed this amount, but it may tend to tail off towards the end, as the electrical saturation point is approached.

Generating Possibilities.

There is sure to be an appreciable improvement in the operating efficiency of generating plants during this period. If we take the coal consumption at a figure of 1·33 lbs. per kilowatt-hour, the amount used per annum to produce the above output will be slightly less than 48 million tons, equal to about one-sixth of the present annual output of our coal fields.

We have now to consider the problem of providing suitable sites for the accommodation of this additional plant. Of the 1,000,000 kw. on order, about three quarters is to be installed as extensions of existing power stations, and the balance on sites already secured. The next million kilowatts will probably be distributed equally between the then existing stations and sites which have been provisionally selected. Of the next million kilowatts, one quarter may be placed in the then existing stations, and new sites found for the balance. All further extensions must be on new sites. So far as can at present be judged, substantially the whole of the plant required to supply the above output must be placed in localities and areas where the matter has not as yet received any consideration whatever.

We must assume that standard units of plant will be used from 25,000 kw. to 50,000 kw. in size, depending on the density of the load in the neighbourhood of the station. It is doubtful whether it will be found convenient to install more than 250,000 kw. on any one site, and in many cases the limit will be 100,000 kw. to 150,000 kw. It would, therefore, appear as though some 80 to 100 new power stations will be required in the future, each containing from four to six generating sets, operating on an interconnected network supplied at 66,000 volts, as this is at present considered the limit for underground cables. When possible, these power stations will be placed where an adequate natural supply of water is available for condensing purposes, and where fuel can be conveniently transported. Of the two, under present circumstances, water is undoubtedly the most important; the only alternative is the provision of reservoirs, cooling towers, pumps, &c., which not only involve considerable capital expenditure, but also increase the operating expenses.

The Water Problem.

In the immediate locality of many of the most important industrial areas, there does not exist a natural supply of water sufficient to run even 25,000 kw. plant during the dry months of the year, and in order to secure a site possessing ample facilities in this direction, all the year round, for a plant of 100,000 kw. to 250,000 kw., it would be necessary to construct the power station 20 to 10 miles away. This is the problem that has to be faced in certain districts in the Midlands; also in Lancashire and Yorkshire, where the ultimate demands in areas of 100 to 200 square miles may reach and exceed 500,000 kw. It is not a question similar to that which has been solved in other parts of the world where coal is expensive, of transmitting the energy obtained from water power over long distances. In such instances, the running cost per unit is negligible, and the transmission losses consequently of no importance. Nor is it a question of seriously considering whether it will be a better proposition to generate at the collieries and transmit energy electrically or alternatively to transport fuel, and generate locally because there are few if any sites immediately adjoining collieries which possess an abundant supply of water. The particular districts mentioned above are all situated within easy reach of many collieries, and coal freight charges are therefore low. By reason also of the railway facilities already provided to handle the products of the districts, the selection of a site suitable for the handling of fuel in large quantities is a much less difficult matter.

There is no doubt whatever as to the desirability of utilising as fully as possible any large water supplies which exist at distances convenient to the centre of gravity of industrial loads, but it will be a grave mistake to claim that all future power stations of large or moderate size must be placed adjacent to such supplies, if in connection therewith lines 20 to 30 miles long have to be used to transmit the large amounts of power required. Assuming the same price of fuel per ton, delivered into bunkers, the difference between the cost per unit generated by a large plant operating on a site with a natural water supply, and a plant of the same size placed in a position requiring the use of cooling towers, is unlikely to exceed even if it reached 10 per cent. It naturally follows that if the cheapest possible supply is to be our goal, an appreciable number of the large plants to be put down in the future must adopt artificial cooling arrangements.

The Proper Place for the Power Plant.

Two important points have to be borne in mind. The first is that the proper place for any power plant is in the centre of the supply area, but in many important industrial districts the only available waterside sites are so situated that the bulk of the output must be transmitted in one direction. Under such conditions the transmission costs attain maximum value. In certain areas a combination of several towns will easily provide sufficient load to justify the erection of a station containing large units of plant, and by using cooling towers supplemented by such natural water as exists, the station can be placed in the most favourable position, both from the transmission and distribution point of view.

The second and perhaps the most important point is that the next 20 years may see radical changes in the methods of large scale production. The thermal efficiency obtained in converting coal into electrical energy by means of steam boilers and turbo-generators is unlikely to much exceed 20 per cent. Quite an important step forward will have been made if all coal is used at this efficiency, but still further progress is probable in directions which do not involve the provision of large quantities of cooling water. For instance, should large internal combustion turbines become a practical proposition, the power stations containing such plant would certainly be placed near to the centres of demand, and any expense incurred in constructing long-distance transmission lines to waterside sites would be wasted.

The foregoing remarks suggest that, on commercial grounds, long transmission lines cannot be employed to any considerable extent in connection with schemes where heavy industrial demands arise in comparatively small areas, but in thinly-populated districts engaged, say, in agricultural pursuits where the total demand will be small, the problem is quite different, and in such cases it will be found desirable to obtain the supply from a large power station even although it may be situated 40 to 60 miles away.

Mass Production and Efficiency.

No scheme of mass production is worth even trying unless it ensures that the product turned out will perform its functions in the most efficient manner. As Dr. Edward Hopkinson, in his Presidential Address to the Institution of Mechanical Engineers, said, "It is insufficient to build an efficient machine, it must be built efficiently." As "Machinery" points out, production is an art dependent upon the estimation of small discrepancy it aims at similarity by the road of difference, hence the great and outstanding need of all methods of mechanical control whose value were proved in the time of national crisis. In any retrospect of the war era from an engineering standpoint nothing is more marked, and nothing is more likely to be discarded upon the resumption of commercial manufacture. Whitworth was the pioneer in this as in many other fields, but the method of limit and tolerance, similarity and difference is the only means yet devised to ensure duplicate results in practice.

The Control of Industry.

By **ERNEST J. P. BENN, C.B.E.**

Editor of "Ways and Means"

One hears and reads a good deal in these days about the Control of Industry, but the phrase is used by many different people with as many different meanings. For some years past the Government has been in control and has exercised a sort of supervision and restraint without accepting for the most part any of the responsibilities which are inseparable from control in the sense in which the word is used when talking of the future organisation of our industrial life. The world has developed so rapidly in the first 20 years of the 20th century, that in approaching a subject like this it is necessary for most of us to pause and take stock of the situation and endeavour, so far as we are able, to accommodate our ideas to the new world in which we are living, even though most of us have not yet realised that fact. In these 20 years we have felt for the first time the effects of a course of free popular education which was unknown to our grandfathers, which was an experiment with our fathers and is an accomplished fact with us. The industrial army is no longer composed of great masses of illiterate workers, not only willing to work but willing to look to a master for guidance and responsibility and control. There is much more human equality between the classes to-day than at any previous time in history. I am not now talking of the temporary war conditions which have produced a natural shortage and have given to organised Labour powers arising out of national needs which, like the powers of the profiteers, are exceptional and ephemeral and will pass. I go deeper than that, and I contend that we must recognise an actual moral and political equality which was not a factor to be reckoned with when the industrial system as we know it to-day was founded and perfected. We have, therefore, to make up our minds that we shall never return to the old relative status of master and man, which was the basis upon which our factories and our business and trading concerns generally were founded.

The Revolt Against Work.

There is another big fact upon which those of us who are getting on in life would do well to ponder, in order that we may avoid the error of attempting to settle present problems on past experience. The 19th century as a whole may be viewed as a period of experiment in the application of science to industry. We enter the 20th century with a full knowledge shared by all of us, from the highest to the lowest, that the experimental stage has passed, and that science in its many manifestations can be made to take the place of work. Whereas the boy of 1820 had little to look forward to, if he would succeed, but a life of hard, strenuous manual or personal toil, the boy of 1920 looks to machinery, to electricity, and to brain-power to take the place of much of that personal muscular effort which was the lot of his great-grandfather. The world is in revolt against work; some, no doubt, join in this revolt because they do not like work, while others are actuated by the feeling that a great deal of work which is now done is degrading, is unnecessary and is wasteful.

The main characteristic of the industrial organisation of the 19th century was the autocratic position occupied by the employer or the owner, commonly called the "master," a term which has in these days ceased to be applicable to the situation. The employer was entirely responsible for all the conditions under which the industry was carried on, the employee was absolutely at his mercy. In the latter half of the century trade unionism developed and did succeed to a very considerable extent in robbing the autocratic employer of the ability to use his powers harmfully, but trade unionism did not do much to alter the seat of power; its efforts were chiefly directed to restraining its abuse. Trade unionism in the last generation could do little else because it was dealing with a population of workers possessed of a low standard of education and consequently free from all those disturbing ambitions and ideals which together constitute that unrest of which we hear so much to-day. The power and the menace of trade unionism is greater to-day than ever, not only because of the numbers of its membership, but because of the superior intellectual forces contained in that membership. These are reasons which lead to the view that any return to the autocracy enjoyed by the employer of the past is not only undesirable, but on the facts, as we now know them, utterly unthinkable and impossible. There are still many employers amongst us who find it difficult to grasp this fact; they cannot rid themselves of their traditions; they cannot accommodate themselves to the advance that has been made since they started in business. These men are, in my judgment, much more dangerous to the community as a whole, much more likely to be the cause of trouble, than the most revolutionary of our numerous irresponsible agitators.

The Industry of To-day.

A study of the industrial position of the world at the moment is surely more interesting and more informative than at any previous time. We have employers still amongst us of the old "master" type on the one hand, and we have actual working examples of the wildest form of Socialism in the Soviet on the other. These two things, belonging to two entirely different worlds, actually exist side by side in Europe for our edification and instruction. Between these two extremes in the various forms of industrial control we have a wide variety of modification of one or the other. There are numberless schools of thought, innumerable shades of opinion, all striving for the ascendancy in the most important of present-day discussions—the Future Control of Industry. The old-fashioned "master" is dead or dying, never to return. Similarly, thanks to the Russian revolution, the Soviet is as good as dead, when the facts come to be known; it is evident from the scraps of information that are reaching us, that the Marxian theory as practised by Lenin will be shown to have utterly failed to provide the people with the necessaries of life. The Soviet Government has only succeeded in those branches of activity where it has adopted Capitalism and Militarism. The question with which we in this country and industrial students the world over are now struggling, is to find the form of industrial control which will give us the maximum results in service to the community with the minimum of effort and inconvenience to those who have to produce those results. We are divided to-day into very definite parties, although the division is not clearly discernible or generally recognised yet. Some of us believe in Capitalism, others do not. The latter are by no means confined to workers, revolutionaries or wild Socialists, for there are many professional and educated persons who at heart feel that the basis of work and wages and profit upon which Capitalism is founded is wrong. I look forward to an early split in the Labour Party itself, as the day cannot long be delayed when each Labour leader will have to decide to which of these parties he desires to adhere. The guildsmen, the syndicalists, the Marxians and all those who talk of the ownership and control of the means of production or of the right of Labour to the whole of the product are definitely opposed to the Capitalistic system. They are followers, with reservations, of Plato or William Morris, and they picture a world from which money, wages and private gain are eliminated. These people imagine that industry can be run without the one and only thing that so far has caused industry to go at all, the incentive which comes from personal gain. I am one of those who can see the possibility of something of the kind happening in the future centuries when we have succeeded in breeding a race of human beings who have conquered most of the weaknesses with which we present-day creatures are afflicted. I do not, therefore, dismiss the communistic idea as absurd. I content myself with the assertion that it is utterly impossible in this century at least, but that it should be cherished as an ideal which cannot fail to have an elevating influence upon mankind.

Nationalisation Will Not Work.

Next in order of importance are the Nationalisers, who occupy the position which is really halfway between the old industrial autocracy and the modern Soviet. The Nationalisers are in a way the most practical of all the Socialists; they admit the need of Capital; they adopt the advantages of the banking and currency systems which have been the greatest of the forces of civilisation, and they merely want to substitute for private ownership and private responsibility the collective ownership of the State. They claim very rightly that industry is a national service, that its purpose is to provide for the community, and that those are matters which should be in the hands of public authority rather than in the hands of individual persons. I am a nationaliser at heart; I think that nationalisation is right in theory, it is merely a step towards that more beautiful ideal so wonderfully pictured for us by William Morris. The only thing that is wrong with nationalisation is that it will not work. We have had a good deal of nationalisation in the course of the last five years and we know how it pans out in practice; we have actual figures to show that it adds immensely to the expense of any work which is undertaken in this way. When an industrial concern is nationalised, you substitute for one responsible individual at its head a host of irresponsible officials who cost a great deal more and, from their irresponsibility, are far less efficient. At the beginning of the war there was an outcry because timber brokers were making a lot of money. The timber trade was nationalised and a Timber Control established. Timber brokers were practically ruined and the country was rid of a handful of wealthy men, but the sum total of their wealth was a mere flea-bite compared to the enormous sums that were spent in rendering the same service which they rendered under a system of nationalisation. The moment that a piece of work passes from the category of private enterprise to public service it is absolutely certain to introduce complications and formalities which, however much we may laugh at them, are an essential part of public work. Nationalisation is, therefore, condemned on the simple score of expense, and however much we may feel the imperfections of a system which enables a small minority to amass great wealth, we have as business people to recognise that that wealth represents much smaller charges upon the consumer or the community than any other industrial system yet devised or suggested. I have not space to go into other points of the nationalisation argument; they are all practical points and do not weaken the concession which I make to the Socialists, that the theory of nationalisation is good. In practice it leads to the stopping up of progress, it standardises and stereotypes everything it touches. The industrial organism under private enterprise is a seething mass of new ideas, new experiments, most of which arise from the desire for personal gain, a desire to which nationalisation offers no hope.

"Whitleyism" the Practical Solution.

At this stage the reader may ask what practical solution I have to offer. I dismiss the old industrial autocracy, I find no hope in the Soviet, and I condemn as unworkable the middle course known as nationalisation. My answer is contained in the one word—"Whitleyism." I believe that the committee established by Mr. Asquith, over which Mr. Whitley presided, found the whole of the wisdom yet evolved on this question of the Control of Industry. I do not think that the committee was conscious of the historical nature of the work that it was doing. The report itself is already out of date. Mr. Whitley and most of those associated with him have advanced a very long way since they penned their circumscribed suggestions for the establishment of better relations between employers and employed. I need not remind readers of The Electrician of the points of the Whitley Report; it recommends that every industry should be thoroughly organised according to its needs, and that the various classes which compose it should through their respective organisations constitute a Joint Industrial Council, which should act as the Parliament for that industry. The Whitley Committee had a very limited idea of the possible functions of the Joint Councils which they recommended; they were restricted by their terms of reference, and the 11 heads under which they classify the responsibilities of these Joint Councils are mostly concerned with what are known as Labour questions. But since those days, chiefly owing to the concentration of the mind of the nation upon industrial efficiency, it has become evident that there are many matters connected with every industry which should be the common concerns of all the classes and all the persons concerned in that industry. There is, in fact, in connection with every trade, a politics in which all the citizens concerned in that trade have a right to a voice. Whitleyism has evolved a new branch of Government, and my belief is, that just as we have a system of local government which takes in hand all those questions common to localities, so in the future we shall have a system of Trade Government which will concern itself with all those questions common to the members of any given trade. We know from experience that it is possible to impose a system of government upon a locality without any undue interference with the liberty of the individuals who reside in that locality. Similarly it will, I think, be found possible to impose a system of government upon an industry which will not interfere with or restrict the personal rights and liberties of the members of the industry, so far as those rights and liberties are compatible with the public good. The Whitley movement has one transcendent charm about it which constitutes its great strength. Strange as it may seem, it can embrace within itself men of the most widely divergent views. There is no reason why the wildest Bolshevik cannot accept the Whitley Report, nor is there any reason why the most hide-bound of mid-Victorian Tories cannot take a seat on a Whitley Council. All that is asked of either of these extreme persons is that they will adopt an attitude of honest inquiry. The Whitley Council is impossible to the bigot in either camp who thinks that he has found revealed truth and that there is nothing more to learn in connection with human development. The only persons who object to the Whitley Report are people of this type, people who from the start are perfectly hopeless, and who, as I have already said, constitute at both ends grave dangers to industrial peace.

What a Whitley Council Does.

A few words about the work of a Whitley Council, or as I prefer to call it a Trade Parliament, will make this point somewhat clearer. There is a great deal to do in connection with the development of each of our industries which cannot be done under the old scheme of intensified individualism, and which can be done by Socialists and Capitalists unitedly, without asking that either of them will forego one jot or tittle of the faith which they profess. Education is the first great subject that springs to mind. We have the example of Germany and of America to guide us; we know that we are woefully deficient in technical or vocational education. On examination we are astonished to find that we are spending two millions a week of public money on so-called technical and trade classes, and that those courses are conducted by authorities who have no single shred of official connection with the trades they profess to teach. Here, at a stroke, is a vast field of work upon which all parties and all classes can combine through a Trade Parliament, and which must be done whatever system is eventually adopted for the control of our industries. Scientific research is another branch of vital work to which we have failed to give due attention. Each of our industries depends for its life upon a continuous inward flow of new knowledge, and yet we have been content in the past to leave this vital need to chance. Many of our industries must disappear, lock, stock and barrel, if we continue to leave systematic scientific research to the Germans, the Americans or the Japanese.

The costing system, about which so much has been heard in these days, is merely a single detail of the great science of statistical research, another branch of work that will be undertaken by Trade Parliaments in the future.

Labour and Research.

Some people may say, What has Labour to do with scientific research, what use can Labour be when the problem is one for chemists or mathematicians? To that I answer—that taken as a whole there is as much knowledge of chemistry and mathematics to be found in the ranks of the labourers as will be discovered in the ranks of the employers, but after all that is not a real answer. Going back to my parallel of local government, one can ask with equal force how much the average elector knows of the problems of sanitation or public health. The introduction of new scientific truth is vital to the life of an industry, and the life of an industry is of much more importance to the thousands of employees who work in it than to the hundreds of employers who direct it. But there is a better answer still: the industry itself is threatened at this moment by the discontent of workers who feel that they have no real share in it, no interest in its development, and that they are merely wage-earners, pawns in the hands of those who constitute the employing class. Surely the best way to remove that danger is to attack it at the roots, and to give to the workers through the medium of such problems as education, science and statistics an opportunity not only to know of, but to actively participate in these great matters upon which the future of the whole of us depends. The possession of a municipal vote does not cause the working man to interfere on questions of the design of a drainage system or the composition of a filter-bed for the water supply, but it does ensure that proper attention is given to these matters and it does act as an incentive to greater effort on the part of those who have the practical problems in hand. Similarly, the possession of an industrial vote through a Trade Parliament by the cotton operative would not mean that every little Lancashire weaver would be claiming a right to interfere with the development of cotton growing throughout the Empire, but it would mean that an impetus, a force and a power would be placed behind those who are anxious about this urgent and vital problem which is sadly lacking at this moment.

Joint Responsibility.

The position that we thus reach in connection with the Control of Industry is an interesting and unexpected one. We find that employers on the one hand and employed on the other have in the past been so engrossed with their own individual and selfish interests as to forget that there is a wider field more important than either which has hitherto been neglected—the development of the industry itself as a part of the social organism and as a branch of the national life. Capital and Labour have now the opportunity to control jointly this new field without interfering with each other in connection with those matters which have hitherto been regarded as the exclusive province of one or the other. The acceptance of this joint responsibility for this new work must have the effect of bringing to each party a better appreciation of the point of view of the other and rendering far easier of adjustment all those differences which give us so much trouble to-day.

Education and Research as Factors in Modern Management.

By A. P. M. FLEMING, C.B.E., M.Sc., M.I.E.E., J. G. PEARCE, B.Sc.(Eng.), A.M.I.E.E., and H. J. BROCKLEHURST, M.Eng.

THE successful management of a modern business depends largely upon three factors—efficiency of organisation, the attitude of mind of all grades of workers towards the business, and the provision made for expansion and development. These three factors are very closely associated with education, industrial research, and with that provision which has become known as welfare.

The present demands on the part of labour for shorter hours and higher wages necessitate increased productivity, which can be very largely secured by increasing the efficiency of existing industrial processes to a maximum through industrial research. The fullest co-operation between different grades of workers, particularly between labour and management, and for a better understanding on the part of workers of their particular functions in industry, together with the necessary degree of manual skill, can be obtained by an enlightened system of industrial education. Through such education, and by welfare provision, modern management testifies to its recognition of the importance of the human element in industry.

Mass Production in the Electrical Industry.

The modern tendency towards mass production provides a means whereby a very large demand may be satisfied with a minimum expenditure of effort, time and money. Its operation in cheapening production increases demand which makes it possible to enlarge output still further. The question of mass production, however, in the electrical industries, is a problem of an entirely different character from that obtaining in an industry mainly concerned with assembling parts, often purchased from other works, into a standardised product having only one design or type and one size. Such industries do not solve the problem of large-scale production; they merely transfer some of its most difficult aspects to subsidiary works. In general, however, the conception of a central assembling works receiving parts from other works is useful, and the practice is paralleled by the organisation of large electrical works into "feeder" and "assembly" departments. The electrical industry is extremely complex. It is inevitable that large sizes of apparatus should be built to order, and each such order is virtually a special and non-standard job. Even for apparatus in the manufacture of which some measure of standardisation has been introduced, there still exists a variety of voltages and outputs and other variables which prevent manufacture being as straightforward as the assembly of standard parts in one model. In many classes of apparatus the demand is far from being predictable and certain, and, indeed, in some cases, the magnitude of business available does not warrant the expenditure of heavy capital outlay on tools, &c., which mass production would involve. The manufacture of some products required in electrical manufacture, such as electrical steel, insulating fabrics, varnishes, copper conductors, &c., cannot be considered in the same category as a mass-production assembly proposition. Furthermore, British industry has always been characterised by very large and widely ramifying export markets; such an export trade implies the existence of very widely varying types of demand, and the process of educating even the technical buyer to accept standard articles is comparatively slow. A rigid system of standardised production is incompatible with providing the buyer with what he requires at all costs, and it is not possible for British trade to meet both requirements unless many different types of industrial organisation exist.

The electrical industry, however, is adapting itself to newer conditions with considerable success. The process of amalgamation will result in financial stability on which large schemes can be based, and instead of many works with overlapping manufactures competing for a limited home market, there will be a greater degree of co-ordination for attacking export markets.

Mass Production demands Scientific Control.

It is well known that in any manufacturing process on a large scale particular care has to be taken to include safeguards such as continuous inspection and testing at each stage of manufacture, to ensure that work in progress is likely upon completion to give the desired performance. More so than is necessary in the more primitive types of shop organisation which precede mass production, this latter method involves the use of such checks upon manufacturing processes, and especially is this the case in the electrical industry, which involves a very wide range of materials subjected to electrical and mechanical stress. The distinguishing feature of mass production for electrical manufacture should therefore be that of scientific control, exerted through some definite department of the works organisation. The objection occasionally urged against standardisation that is, its tendency to inhibit progress and development – is also corrected by the provision of means whereby progressive development can be ensured.

The instrument which industry has created to undertake this scientific control is industrial research, operating in any works through a research department. Research provision, however, is useless, unless workers understand the economies of industry, and are able to appreciate the benefits which research confers upon the community at large, and this necessitates educational work which should run in parallel with research. Industrial research is the provision for the improvement of materials and the factory processes in which materials are employed. Education provides for the systematic development of men. The relation between research and education in industry is much deeper than the academic association which holds good outside industry, and many practical advantages are found in the association internally, particularly with respect to the training of higher staffs for industrial concerns, and in the education of juvenile and adult workers in the benefits of research work.

The increasing application of science to industry daily renders more precarious the position of those manufacturers who relay upon some form of secret process or on some information not generally known for success in manufacture. Admitting the enormous advantage of an existing manufacturing organisation in meeting any form of competition from outside, research for such manufacturers becomes a form of insurance against advances made in the art by others.

Education.

Education in industry has a twofold aim. In the first place, only from education can we obtain that co-operation between all grades of workers which the further development of the industrial system necessitates. Education will result in removing existing suspicions and many fallacies, and will consequently bring an understanding and a sympathy in which industrial questions can be adequately considered. Such education is necessary both for adolescents and adults.

The second object of industrial education is to afford a suitable training period of apprenticeship, whatever the occupation, in order that boys should enter occupations for which they are naturally fitted. In the electrical industry specific practical training in a chosen trade should be accompanied by instruction in such subjects as English, mathematics, civics and economics, elementary science, together with the practical application in various trades, particularly to the specific trade into which each youth will enter. Instruction of this character will be compulsory when the continuation school clauses of the Education Act, 1918, become operative, but a number of employers already permit juvenile employees to have time during the working week for the purpose no deduction for time lost from work being made.

The instructional work may be undertaken in a school associated with the works, and this will have an independent value, although it should be utilised as part of a wider educational scheme rather than be pursued as a narrow end in itself. The necessity for craft skill is in some directions decreasing, in others increasing, but in all cases a much higher standard of intelligence and knowledge is being demanded. Education in a works school affords young people an opportunity of associating, of which full advantage should be taken in encouraging them to develop some means for organisating collective activities and for achieving self-government.

Various Grades of Apprentices.

In the case of a technical industry such as is the electrical industry, there will be various grades of apprentices in the works. Boys from primary and secondary schools will become trade apprentices: young men from senior secondary and public schools for intermediate posts, and graduates and others with technical training from the universities for higher staff positions. Opportunities should be taken to encourage these various grades to mix, so that they help to educate each other. The association of the young men who will be workers, and of the young men who will be leaders in industry, is at this stage of a very beneficial character. A comprehensive account of the grades of apprenticeship required in a modern electrical works, together with details of training of each, is given in the recently published report of the Education Committee of the British Electrical and Allied Manufacturers' Association.*

Particular steps should be taken to ensure that any apprentice, of whatever grade, should have opportunities of rising to whatever post he is fitted by inherent capacity, and any facilities required for further education and training should be provided. As an instance of the tendency towards providing free upward mobility in industry, the action of the Manchester and District Armaments Output Committee may be noted. This body has provided the sum of £17,000 to be spent in maintenance scholarships for engineering apprentices for a period of five years.

Adult workers may be taught much in regard to the function they exert in industry, and the place of their work in the whole sequence of manufacture. A worker who knows, for instance, to what tests a piece of apparatus he makes is to be submitted, and who appreciates the need for such tests, will take a sporting interest in the behaviour of his product, and will be able to make a repair with a much greater degree of intelligence, and with much less supervision. While adult workers are much more fixed in their habits and modes of thought than adolescents, nevertheless opportunities for social and educational gatherings should be provided.

Particular attention should be directed to the importance of obtaining university trained men on the manufacturing side of industry and for overseas work, and the introduction of such men into the shop in an executive capacity is assisted by association with other young workers during the apprentice period. The average university apprentice entering industry requires considerable practical training in order to develop in him a sense of responsibility, and place him in touch with modern practice.

The movement towards the growth of a science of industrial administration illustrated by the establishment of a Department of Industrial Administration at the Manchester College of Technology, is calculated to encourage men to enter the purely manufacturing side of industry and should be strongly encouraged.

Industrial Research.

Research in industry implies not only the seeking of new knowledge for the purpose of developing new industrial processes, but also the scientific control of existing materials and processes, in order that the latter may be maintained at the highest possible level of efficiency in production. It covers a very broad field; it makes use of existing scientific knowledge in chemistry, mechanical and electrical engineering, metallurgy, physics, &c., and it employs the sciences of psychology and physiology in connection with investigations on fatigue and motion study. In other aspects it requires the use of economic and statistical science.

The difference between pure science and industrial research is purely one of aim, and both require to be conducted by highly trained scientific men with adequate equipment and buildings Men engaged in industrial research require to have experience in the industry which they hope to expand.

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* *See* The Electrician, Vol. LXIV., p. 379.

In some works a research department may be established. Other manufacturers may decide to make use of university and national laboratories, or of consultants. In any case there should be someone in the works whose function consists in keeping in touch with progress outside, and in presenting the scientific point of view inside the works. Such a point of view is recognised now as being equally as important as the financial, commercial or manufacturing point of view when the manufacture of new products or modification of existing lines is contemplated. The existence of a works research department is not inconsistent with membership of a Research Association. Indeed, some works belong to several such Associations, and also conduct research for themselves, but doubtless many works, especially those small in size, will rely mainly on their Research Association for the information they require.

In the case of a works having its own research organisation, in order to maintain the very closest possible contact between the research department and manufacturing departments it may be desirable for the former to undertake all scientific testing, even of a routine character for the latter, as often the need for investigation is revealed by the results of routine tests on a works process.

THE WORKS RESEARCH ORGANISATION.

The function of a works research organisation includes control of raw material supplies, production of new materials and substitutes, investigation of manufacturing difficulties, and the control of technical processes. Particular attention should be paid to the conservation of waste. A research department, of course, will be very greatly concerned with the development of new methods of testing and the improvement and standardisation of existing methods.

For the electrical industry a research organisation will probably include specialists for research in chemistry, such as is involved in the development of synthetic resins for insulation and other insulating materials, mechanical testing engineers, metallurgists, electrical engineers and physicists for investigations on optics, and illuminating engineers. Such a research department should be supplemented by an organisation for acquiring information and intelligence relating to the work of the company wherever it may be found necessary; provision should be made for ascertaining costs of various investigations.

CONFERENCE METHOD OF WORKING.

Industrial research which has a specific objective, and in which any problem may have to be considered from the angle of view of the chemist, microscopist, or physicist, &c., can be greatly assisted by a systematic working of a conference method among the men particularly concerned. Each man contributes a view based on his experience, and the specialist who is in charge of a particular investigation can then make use of the suggestions made. Some parts of the organisation may require to have a responsible leader in charge, assisted by a number of other workers. In other cases a research specialist may be employed working alone. In a large research department both methods are commonly used.

The research department should undertake part of the training of apprentices in each of the grades referred to above, but particularly for those technically trained young men who will take up higher staff positions on the engineering, commercial or manufacturing sides.

WORKING CONDITIONS MUST BE GOOD.

In considering buildings and equipment for research workers, it should be borne in mind that the large majority of the expenses connected with running a research organisation are due to staff salaries, and any laxity in providing highly-paid staff men with the equipment required, or any failure to provide them with working conditions which conduce to the highest possible efficiency, is not true economy.

In the majority of the few instances of works already utilising mass production the question of scientific control has not been emphasised. In some cases this has been due to the very simplicity of the process which encouraged the development of production on a large-scale basis. For other cases, the scientific aspect, with regard to selection of materials and processes, has been thoroughly worked out prior to consideration of actual manufacture. Some of the most successful examples of mass production have been based entirely in this way on scientic work.

WELFARE.

Welfare in an industrial works is that provision made by the management, through the advice of an officer appointed by the management, for securing working conditions which conduce to efficient operation. Such provision does not dispense with the need for works committees or some other form of representative committee as a means of ventilating grievances and raising suggestions. Such welfare provision includes adequate air-space, heating, lighting, ventilation, rest periods, canteen accommodation, medical and surgical advice, and the services of an employment officer. It should be dissociated clearly from arrangements made for recreative and social functions. In the latter cases, true welfare consists not so much in helping workers as in helping them to help themselves. They should be encouraged, advised and assisted in every possible way, short of having the actual work done for them, in connection with the arrangement of social functions, &c. The whole idea behind welfare work is that workpeople should be self-governing, and anything savouring of philanthropy or undue interference, and which tends to injure the independence and self-respect of workers, should be scrupulously avoided.

As under systems of mass production works tend to increase in size, some organised method must be adopted to keep workers in touch with the ideas and attitude of the management, as daily personal contact is impossible. The educational work provides a link between young and adult workers and the staff, but the works committee should be utilised as well. The welfare supervisor may then be considered the channel through which the suggestions made by the works committee can be given effect.

High wages alone have failed to provide a complete solution of the problem of industrial unrest. It is largely because this is the only channel through which workers may become articulate, that so much mention is made of it at the present time. However, through the operation of a proper system of education this condition need no longer apply.

A more important aspect of the problem of unrest is the feeling on the part of workers of a need of opportunities for self-development and self-expression, and for a share in the control of conditions of work. These aims cannot be realised unless the demands of production are fully satisfied, and this latter condition can only be accomplished by the application, through research, of science to industry.

"A Piece-Rate System and Notes on Belting."

A book recently published with this title contains two of the more important Papers which the late Mr. Frederick W. Taylor read before the American Society of Mechanical Engineers, together, also, with the discussion which followed the reading of the Papers. The first, "A Piece-rate System," a Paper read in 1895, is a brief account of certain phases of that work which made the author famous.

While Taylor was establishing his system of management he had excellent opportunities of studying problems that vitally affected his scheme. One of the most urgent of these was the problem of belting, and the Paper, "Notes on Belting," written in 1893, is the result of nine years' close observation and experiment on a variety of belts in his machine shops. The main results of the experiments are set forth and provide an excellent "belting table" for works' use.

As an introduction to the book, a short appreciation of F. W. Taylor, written by Mr. P. B. Copley, appears. The essay is in the nature of an impression received as the result of two interviews with the originator of "Scientific Management." It is unfortunate that the scope of this introductory article should be so limited, and one feels that the space could have been used to greater advantage by giving a short biographical sketch of the life of F. W. Taylor.

While admitting the value of the Papers reprinted in this book, the subsequent developments have been such, especially in systems of wage payments, as to attach historic importance to these writings rather than to assign to them pronounced value for present use.

Mass Production.

By H. W. ALLINGHAM, M.I.Mech.E., M.A.S.M.E., &c.

THE term "mass production" is one of which a great deal has been heard during the last twelve months in the engineering trade, particularly in prospectuses. The idea has caught the public imagination—it has been put forward as the reason for the great accumulation of wealth in the U.S.A. But I think it would be desirable for a moment to consider what should be meant by "mass production"—the meaning which is being applied to it in this country by company promoters and journalists is very different from the meaning it should carry.

For instance, a firm which before the war manufactured a range of, say, 25 different electric motors and generators, in quantities from single machines to batches of 100, decides that it will confine its varieties to six, and put through 500 to 5,000 per annum of each. It has no hesitation in stating in its prospectus that it requires additional capital in order "to manufacture motors on the mass production principle," without any clear definition of what mass production is.

We have in this country certain industries which have followed my idea of mass production for many years—since their inception in fact—such as the manufacture of chemicals, textiles, machine-made garments, boots, certain food products—*e.g.*, margarine, &c. But the term mass production has never been applied to them, because it was not required. They are industries whose products were unsuitable for production by any other means.

The Difficulties of Mass Production in Engineering.

There were several presumable reasons against applying exactly the same production rules to engineering work. First, our factories had grown from small beginnings, and there were numbers making the same products in competition, combines not being at all frequent. Second, our markets were not believed to be large enough to absorb enormous quantities of standardised articles. Third, we have always tended to change in design whenever research showed capabilities of improvement. Fourth, the tendency has been to meet the demand not to create it.

A Definition of Mass Production.

The country of large outputs in the engineering trade has undoubtedly been the U.S.A., and in that country the term "mass production" originated, coming to the forefront less than ten years ago; therefore, I think the definition of "mass production" should be based on the understanding of it there. Many definitions could be adduced, but I will try to give one which can be put alongside the many manufacturing programmes now being developed, and which can show them either in or outside the class: "Mass production" is manufacturing in such large quantities that the plant is laid out in the correct balance, and preferably in sequence, so that the work may pass from operation to operation consecutively. In general, hand in hand with mass production goes the special designing of the plant to carry out each operation in the most economical way, and machines are not changed over from one type of job to another, but are permanently set up for one class of operation only.

From the above it must not be imagined that mass production necessarily means that no changes are ever made. In the textile industries, for instance, mills work on specific orders, which vary one from another, but the main operations in any one mill are all the same, and the plant is in sequence and balanced. So also in such industries as the manufacture of soap or chocolate, buildings are such as to make the very best use of gravity, plant is specially designed for every operation, but changes from one variety of the product to another are not infrequent.

Mass Production in a Gas Fittings Factory.

Such developments in engineering works in this country were very rare before the war, but it is many years since I first saw examples in the U.S.A. I well remember the works of one of the largest producers of gas fittings in Chicago. The brass foundry was on the seventh floor, the castings passing by gravity to the stores on the sixth. Gas cocks were tapped on the fifth, being delivered down a chute on to a pile alongside the machine which held the cock by compressed air, the two ends being tapped from the black casting. The output by one man on $\frac{1}{4}$ gas cocks was from 800 to 1,000 per hour. Upon the jaws opening, the cock body fell down another chute alongside the machine for reaming the taper hole on the fourth floor. The assembly was on the second floor, the finished stores on the first, with packing and despatch on the ground.

I was also much impressed with a large foundry having an endless travelling floor some 400 ft. long. It passed the moulding machines, between which there was space for the core-setters to work, and then came alongside another floor travelling at the same speed on which stood the men who poured the castings. Fig. 1 will illustrate the lay-out. I give these two examples somewhat in detail, as they are interesting in view of the fact that they have been in existence for nearer thirty than twenty years, and are further advanced than anything I have so far come across in the engineering industry over here.

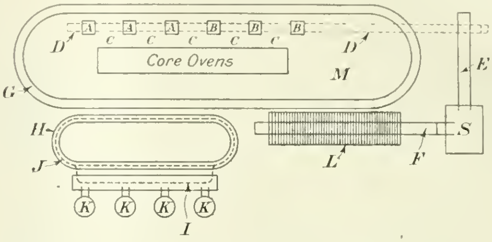


Fig. 1.—Lay-out of a Mass Production Foundry Floor of Thirty Years Ago.

Explanation :—

AA and *BB*.—Moulding machines in pairs, for top and bottom flasks, with core setters
C.—In between.
D.—Overhead conveyer, bringing sand to chutes over moulding machines.
E.—Conveyer at an angle to bring sand from sand mixer and damper *S*.
F.—Conveyer underground to bring sand to moistening plant *S* after it falls through grid *L*.
G.—Main travelling floor for moulding boxes.
H.—Travelling floor for pourers, on to which they step when ladle is full of molten metal.
J.—Moving overhead runway to support ladle.
K.—Cupolas, with stationary overhead runway *I*.
M.—Snagging and cleaning space.

Mass Production and the Motor-Car Industry.

From what I have said it will be evident that I do not consider most of the self-styled "mass production" schemes talked of lately to be anything of the sort. There are, however, many grades of mass production. For instance, most factories which could well claim mass production methods would probably have some departments not on mass production. I will illustrate my meaning by taking a hypothetical case in the motor-car industry, as this industry has, more than any other, made use of the term. Let us consider a factory which is going to produce all the major chassis components for a normal four-cylinder 15 h.p. car.

These components consist of a certain number of what we may call major details—*e.g.*, cylinder block, crankshaft, &c. Now the method and plant used for producing such parts are entirely dependent on the quantities, so that, firstly, our programme must be settled. If we are hoping to make any use of "mass production" methods it will be found that, unless an output of 10,000 cars per annum be decided upon, very few major components will come into the mass class. An output of ten thousand cars per annum means about one every ten minutes, or a "ten minute schedule," assuming one shift only is to be worked. Wherever more than one piece per car is required the production rate is increased; for instance, it would be as well to plan for connecting rods on a two-minute schedule, allowing for spares, scrap, &c. The method of dealing with different production rates for connecting rods was most ably described by Mr. H. C. Armitage, in a Paper entitled, "Jigs, Tools and Special Machines," read before the Institute of Mechanical Engineers on March 21, 1919, in which he worked out the plant, &c., required for six, twenty and sixty per hour respectively.

An output of ten thousand cars per annum, or ten-minute schedule, would mean, however, a far from perfect plant layout, as we should be faced with the faster operations on the major components being done in much less than ten minutes, which would mean that the machines in question would be standing idle between operations, for they could not be used on other components without holding up the flow of work, and entirely upsetting the "sequence." In certain special cases, such a break-away would be essential, and indeed would merely mean that one group of the operations was on mass production and others not. Also, probably not over 25 per cent. of our plant would be on mass production, the balance being grouped by types of machines in the customary manner, and these machines changed over from one job to another from time to time

Importance of "The Order of Work"

In this connection I will make passing reference to the desirability of more detailed planning of "order of work" than is usual in this country. In the case under discussion it is quite possible, once the methods, tools, production rates, piece work prices, &c., have been standardised, to work out a weekly or monthly programme covering each machine or group of machines, and to pass batches of all the parts which require a particular operation through the department in accordance with a pre-determined programme. By this I do not mean that a clerk can take the place of the foreman, but the clerk can be given a programme calculated for months ahead, and be instructed that, if there seems any likelihood of its failure, he is to notify the works manager immediately. The working out of such a programme will be understood by taking a very simple example.

Mass Production of Dynamos and Motors.

Suppose we are going to manufacture forty 5 h.p. and ten 10 h.p. dynamos weekly. We will consider turning the armature shafts, and suppose the average production times are one hour and two hours respectively: we find at once that the machine hours needed are sixty. We must therefore allocate two lathes; we should probably say, "We must start the 5 h.p. shafts on (say) Monday at 8 a.m., and if not started by Monday night notify works manager." The 10 h.p. shafts might be started any time convenient (dependent on jobbing work on the second machine) up to Wednesday, or we may plan to put twenty or more through in one batch. But the main thing is to plan that they *must* be finished through each operation so as to be in time for the assembly programme. By working out a regular rotation scheme it is possible to make quite small programmes approximate closely to mass production, for the balancing of plant can be carried through quite a long way, though unless the range of product is very much alike, consecutive location of operations is often difficult to attain.

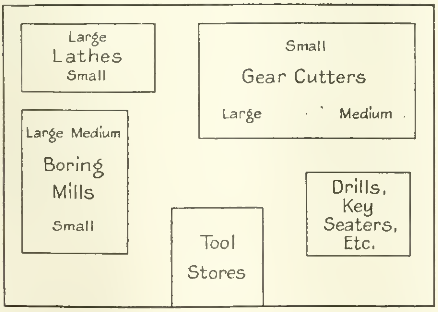


Fig. 2.

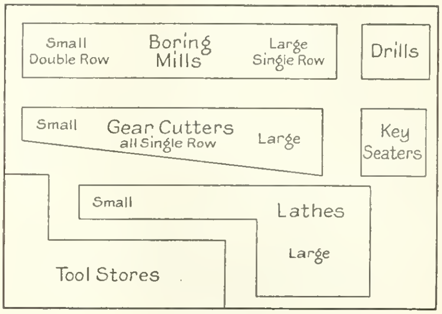


Fig. 3.

Much more may, however, be done in this direction than is done generally. As an example I give a case which came within my own experience nearly ten years ago. The case was that of a new factory which was being equipped for the general manufacture of all sizes of cut gearing, both in cast iron and steel, in lots ranging from single units to many hundreds.

The shop was built and the preliminary layout prepared by the drawing office was somewhat as in Fig. 2. After some days of careful consideration a complete alteration of the layout was made, the plant being arranged as shown in Fig. 3. The disadvantages were that the foremen over lathes, boring mills, and gear cutters respectively had a longer walk from one end of their section to the other, but the carting of the work was enormously reduced. I do not suggest that this alteration to layout caused the shop to have any claim to mass production, but I think some mention of the value of studying layout may not be considered out of place.

The Need of Creating a Demand.

One final aspect of the subject which I wish to touch on is the habit mentioned at the beginning of this article, that we have tended to supply a demand, not to create it. We say, "There is such and such a demand, and we can get such a percentage of it, hence our factory will be so big, and our costs so much." The American says, "I can make so many at such a cost, and so many (perhaps ten times as many) at so much less, and I guess the market will absorb them at the price I can then afford to sell at," and he has gone ahead and put down the plant for the larger amount. We are hardly yet doing this, except in isolated cases, though we pretend we are and we say we are, but we have learned an enormous amount with regard to the possibilities, and it is, I think, only a matter of a short time before we do really take up the business of mass production and all that is meant by it.

Half Past Twelve.

This is the title of a small booklet containing studies on economic questions for odd half hours. The author is Mr G. W. Gough, who is well known as the writer of "Ten Minutes' Talk with Workers" in "The Times" Trade Supplement. A wide range of subjects is covered including problems and methods of political economy, capital, selling, wages, profits and investments. Its perusal is quite worth while.

Selling an Idea.

By J. W. BEAUCHAMP.

(Director and Secretary, Electrical Development Association.)

At the present time the British Electrical Industry is producing masses of machinery and apparatus, but there is much evidence to show that it is by no means "mass producing" in the industrial sense of the term. Many of the more important engineering products are not susceptible to those methods of manufacture which have become prominent in connection with the production of munitions, and, indeed, too serious an attempt to reduce costs by standardisation and by obliging designers of appliances to subordinate the user's needs more or less to the requirements of cheap and rapid production in the workshop may be against the best interests of an industry which is still rapidly developing. Particularly in regard to heavy machinery, mass production must mean rather the handling of operations in bulk and the division of work between firms or groups in such a way as to reduce the diversity of products and types handled by each organisation.

When, however, the whole electrical equipment of a country is considered, as it may be, as one large and complete installation, it will be apparent that the apparatus and material which is capable of standardised production far outweighs in value that part of the general plant which must consist in large items, the performance and efficiency of which is apt to be more important than their actual first cost.

For example, much of the material of a generating station, almost the whole of that employed in distribution and the appliances used to form the consumers' installation falls within the classes where output and design so greatly affect first cost; the smaller and more diverse become the uses to which electric power is put the more these conditions obtain. In lighting alone every kilowatt of maximum demand upon a generating station may represent at present prices £120 to £150 of consumers' installation expenditure, whilst in the fully electrified house the consumers' outlay on appliances may become very large relatively to the capital cost of the machinery required to feed them. In attacking the cost of producing such appliances, or by any means enabling the users to obtain them with less initial outlay, lies the most promising prospect of rapidly acquiring the immense business of domestic electrification. It cannot be too strongly emphasised that to wait for very cheap electricity to create a demand for expensive consuming appliances is to wait for a long time—in the domestic field, that is. Industry needs power at lower rates and the cost of appliances is, owing to their longer and more effective use, of less relative importance.

The Importance of Cheap Supply and Apparatus.

At a recent function Mr. H. Hirst, of the General Electric Company, referred to the importance of cheap supplies and the probability of electrical energy being produced at figures of the order of 1/10th of a penny per unit. This is an encouraging forecast, coming as it does from one who is known to have interested himself in the possibilities of generation on the largest scale and in connection with methods which promise to cut out much of the waste of heat energy associated with even the most modern steam electric plants. A generation figure of this order would permit the addition of 200 per cent. for detail distribution, and another 200 per cent. for the provision and maintenance of the more costly pieces of consumers' apparatus, resulting in the restoration of our long lost halfpenny per unit for general domestic supply of heat and power.

Assuming that the cost of competing forms of light and heat and money values undergo no great change from present standards it may be regarded as certain that a rate considerably higher than a halfpenny per unit would bring in the whole of the general and domestic business, provided that installation material and appliances could be obtained by the consumers without heavy payments or long term commitments, but probably not otherwise, and as the success of any attempt to produce electrical appliances in great quantity and reduce cost in this way must depend upon the creation of a market able to absorb them, it is most essential that an understanding should be arrived at between the manufacturers and the suppliers of electricity on the important questions of fitting premises and providing appliances, and also of proper inspection and care for their condition and efficient use by the public.

It may even be found desirable to establish trading companies solely to take the output of the manufacturers and to hire or hire-purchase and maintain apparatus upon consumers' premises; such ventures should have the support of supply undertakings which would need to be real and expressed probably in financial contributions based upon and derived from the additional revenue obtained as a result of their operations.

In short, substantial reductions in the cost of producing electricity would permit of tariffs bearing part or all the expense of appliance service, and yet easily competitive with other methods of heating and cooking.

The Difficulties of Domestic Electrification.

So soon as the use of electrical energy becomes at all general for all household purposes, many of the difficult questions concerning individual demand and load factor will disappear, but at the same time the magnitude of distribution work will increase greatly and expenditure upon it may become a very large item in the cost of the unit, at least until general use by night and day leads to a high resultant load factor on mains and plant.

Estimates of the requirements for large residential districts of any class show that the intermediate stage between partial and full domestic electrification may present real difficulties; the gradual extension from lighting to occasional heating and cooking brings remunerative business with little expense; complete electrification with day and night service for water heating will certainly pay for the heavy expenditure involved; but the middle stages of development may call for much capital to be locked up in anticipation of revenue to follow.

The Need for Enterprise.

Neglecting a certain class of business where cost is not a prime consideration, it becomes obvious that the output of appliances and of electricity for general use must depend to a great extent upon the enterprise of the contractor; his position in this connection is most important. He provides the new channels through which the increasing flow of electricity and apparatus must find its outlet, and his reward should be sufficient to make him keenly desirous of extending his business, of adopting methods to suit all classes and all purses, and the prospects of the retail and installation branch of the industry should be good enough to hold energetic young engineers and business men, able to grasp the service idea, so essential in the electrical industry, and to raise even the smallest business above the mere retail trading level.

A serious and combined attempt on the part of the supply and manufacturing interests to make the contractors' occupation a desirable and promising one and to assist those who need it to improve their methods of reaching and dealing with the public might well prove of great value to the industry as a whole. Consideration for the final distributor of a commodity must form a feature of any sound scheme for increasing a market.

If these observations are true of the easy and established business in lighting, how much the more do they apply to the application of electricity to domestic heating, cooking and labour-saving methods. Here we have to sell or hire appliances, the value of which may often equal their electricity-consuming capacity for a number of years; appliances which entail important changes in home methods; to secure success with them may call for instruction to the users and attack upon old-standing prejudices. The vast improvement and economy resulting from electrical methods in the home will ultimately secure their adoption, but this market needs for its development energy, patience and a skilful propaganda of demonstration and personal work; wide advertising alone cannot secure the result at the present stage; the number of firms and of staffs who have sufficient knowledge of household conditions and personal experience of the advantages offered by electricity to tackle this work is distinctly limited, and to produce such people and find means of making it worth while for contractors to seek this class of work and give the attention necessary to ensure continued satisfaction to their customers, is one of the larger problems which must be solved, or much of the publicity work now being done will certainly be wasted and the advent of the electric home retarded.

The manufacturing interests are those most deeply committed in this matter. The mass production of household electrical appliances will entail large expenditure in advance; the improved article and the reduced cost which is the object in view can only come from large output. Yet if to-day the facility existed for that output the deficiencies above referred to would constitute a bottle-neck between the factory and the public, and it appears necessary that those interested should at once give attention to this question of providing an easy path for their productions when ready.

What Manufacturers' Advertising Should Do.

In any manufacturers' advertising campaign the first consideration is one of policy; whether the maker shall dispose of his products direct to the user or through agents and retailers. To a great extent this question is solved in the electrical industry by the fact that appliances cannot be employed without installation work and the supply of energy; moreover, their proper application generally demands some knowledge of local electrical conditions not possessed by the intending purchasers, and for this reason the business must be done through or with the local contractors, using the term in its broadest sense, to include supply undertakings who carry out work for their consumers.

It arises from these conditions that the manufacturers' advertising should take two forms; first, to persuade the retailer or contractor of the advantages of the goods, and secondly, to assist him by creating a demand for them on the part of the public. Obviously, the first effort is individual to the manufacturer, whilst the second can be made more economically and effectively by joint action between everyone likely to gain by its success—that is to say, by the supply and contracting bodies as well as the maker of the goods; but if waste of effort is to be avoided the mere stimulation of public demand alone is insufficient. With a self-complete commodity needing no particular precautions for its successful use, makers can appeal to the public without fear that any action of intermediaries is likely to check or discourage the demand which their advertisements may have given rise to.

With many electrical appliances, however, some attention to local conditions is needed and the users can seldom purchase without advice. Similarly, where advertising takes the very proper form of creating a desire for electrical methods amongst those not using them, inquiries resulting may be sterilised by local difficulties, lack of knowledge or enthusiasm on the part of those who should welcome the opportunity of retailing the goods, high charges for service connections and incidental wiring or insistence on a class of work beyond the means of the intending user. To be effective all such general advertising of the advantages of electricity requires to be supplemented by the policy of the supply undertakings, and by linking the effort with that of all branches in the industry.

It is easy to forget that the consumer does not really desire to buy lamps, or cable, or electricity as such; his need is for better lighting, more comfort in his home or efficiency in his kitchen, and he can only secure it with the help of the appliance maker, the contractor and the supply engineer. Sectional attempts to push the advantages of a service which can only be rendered by team work must lead to waste and to dissatisfaction, with the result of the advertising carried out.

Where Publicity Work has Failed.

So far electrical advertising has been very restricted in extent, and largely directed towards publishing the virtues of appliances and manufactures of interest only to those who have already accepted the argument in favour of using electricity.

Publicity work has so far shown a lack of plan and a failure to recognise that the user can only be fully served by the combined work of at least two, and often three, distinct sections of the industry.

The use of electric power cannot be extended in the most rapid or economical way by advertising the electric motor as one would advertise a lathe. In the latter case, the purchaser obtains a complete article ready for service and needing only power which he can himself apply; in the former it is often necessary to secure the help of a wiring contractor and the services of the supply undertaking before the electric motor can fulfil any functions, in short, the potential user of electric power has to be converted to a method before he can be interested in ways and means of carrying it out, and for this reason all advertising, whether of apparatus, installation material or electricity should devote some attention to all three sections in their relation to the users' service, its costs and economies.

The Electrical Idea.

Within recent months a good deal has been written upon the principles of selling the "Electrical Idea" and of the advertising work connected with it; it is gratifying to realise that the importance of the subject has been recognised at last, probably it will now maintain its position, and we may see a considered and scientific study of salesmanship established for the electrical industry. Where so much remains to be accomplished first attention should be given to the more obviously urgent channels through which new business can be obtained, and so far as concerns lighting, general domestic electrification and small power uses, the development of the showroom and the display of apparatus in use is likely to be the most immediately fruitful in results.

Showroom displays vary very widely in character, and there are many districts where a comprehensive exhibition of electrical appliances in use is difficult to arrange and perhaps unduly expensive for an individual business to support, particularly as some of the publicity arising from it may take time to mature into business; these conditions have to some extent been met by those electric supply undertakings who have maintained showrooms for the information of the public but passed orders received on to the local contractors who were also able to use the central showroom when dealing with customers. It would seem worth while to consider some extension of this idea, the provision of a continuous demonstration of electrical methods jointly by a number of firms or a combination of the supply undertaking and the local contractors; the result would be to produce something rather in the nature of a small exhibition than a direct trading showroom, a live electric house rather than a shop display of electrical goods.

Co-operative Effort.

Such an enterprise carried out, paid for and managed by a number of firms as well as the supply authority, would have the advantage of being able to do many things which might be difficult for an electricity undertaking alone. It is so obvious at present that many quite good displays are marred by unsuitable position, connection with local Government offices, inability to spend money in food and material for use in the appliances, and similar limitations which could all be overcome by an enterprising syndicate of the local firms interested.

To some extent publicity work of this kind has been done by firms who have established electric restaurants in connection with their business in cooking appliances. These have been attractive and successful, but are not sufficient in themselves to bring home to their frequenters the message that electrical methods are right for the home. People come to see the novel features of electric cooking, but stay to bless the restaurant and soon regard it as natural that a good restaurant may use electricity for cooking without in any way proving that the method is either cheap or right for the home. Moreover, it is difficult in practice to hold the balance between the somewhat conflicting claims of a busy and successful catering business and the prime object of its inception: the demonstration of electrical methods of preparing food; so that unless associated closely with a first-class showroom and so arranged that the cooking operations are visible to the public, the electric restaurant cannot be regarded as a complete solution of the continuous demonstration idea.

Showroom Requirements.

Methods must vary with funds available, but there are good reasons for making any co-operative effort of this kind as large as possible, particularly where a town or district is regarded as the shopping centre of a large area. Here an effort should be made to combine all the firms working in the district and to secure premises in the real shopping centre; such premises should be chosen solely with regard to the value of their windows for display and for the ease with which apparatus can be seen without the necessity for entering the shop. The temptation to establish such an enterprise in a side street on score of cost must be avoided; possibly an arcade site is the best where window gazers are sheltered from weather and cause no obstruction. Given premises of this kind it becomes possible to establish a really compelling window display which will induce serious inquirers to enter for fuller details and for the names of the contractors who will supply them with apparatus. In such a display and with a suitable staff an atmosphere different to that of a showroom can be produced. The exhibit becomes more alive and real. The appliances are put forward not so much as interesting but rather mystifying articles, but as tools or means for doing a certain work. Their cost and the cost of using them is less insisted upon than the saving in general expenditure which will accrue to those who adopt them. Similarly and because sales are not sought or made the public will ask for advice on electrical methods, wiring costs, &c., when they would not feel justified in troubling the attendant of an ordinary electric shop, even if they had confidence in his ability to discuss every phase of electrical work. A central demonstration of this kind would justify the employment of good advice in window dressing, and fair expense in decoration and the use of electricity and materials for operating the appliances, whilst friendly action between several such centres would enable elaborate apparatus or window "fit ups" to be moved from place to place.

In brief, the requirement is a localised, small but live continuous electric exhibition, much of which can at all times be seen by the passer-by and which is furthermore associated in his mind with the names of the electrical firms in his own district. Obviously work of this kind would lead to more unity of action between contractors, form a centre where they could agree upon policy, and at the same time increase their prestige in dealing with manufacturers and the supply undertakings.

The Available Rich Reward.

Good was ever the enemy of best, and methods producing such a volume of business as the electrical industry enjoys to-day are likely to change only in an evolutionary rather than a revolutionary sense, but it appears obvious that many of those who speak of and work for the great domestic electrification business do not yet visualise the great change in methods and the magnitude of the distribution work which must precede it, the important business in hire and maintenance of apparatus, calling for real commercial aptitude, which must accompany it, and the courageous policy which will be required from the supply undertakings before electrical energy can be said to be on tap in every home.

Having, however, brought about such conditions there can be no doubt of the rich reward which would await every section of the industry concerned, whilst the resulting changes in home life would probably be of a character which our most ardent propagandists fail to realise.

Possibly electrical methods alone can reconcile the extremes of communal efficiency with individualistic comfort and self-respect, preserve the castle-like character of the Englishman's home, and yet give to him and his the easy conditions of material life which we associated with the somewhat soulless utopias of the scientific novelist.

The Design of the Modern Factory.

By ERNEST G. W. SOUSTER, A.R.I.B.A.

THE outstanding characteristic of the modern factory as distinguished from that of a generation ago is that the building is now designed to conform exactly with the processes which will be carried out within it. Generally speaking, the Victorian factory consisted of a space surrounded by walls pierced here and there with small windows so that artificial lighting was a necessity except during the lightest hours of the day. Piers and columns were placed without any regard to the uses of the building and the sum total result was that maximum production was impossible.

To-day on the contrary, the whole "ensemble" of factory design is approached from the point of view of what may be termed "scientific organisation of industry," which not only means obtaining maximum output from each foot of space occupied by the building but includes the provision of such heating, lighting and ventilating as will conduce to the health and expedition of the workers, and in addition provides for the development of everything which is comprised under the term "Welfare Work."

Problems of Layout.

In a short article it is impossible to consider questions of site and subsoils, but it should always be remembered that a level piece of ground or one approximating thereto will normally be more economical than one of varying levels.

Whilst both the site of the building proposed and the uses to which it will be put are the main factors effecting the "layout" of any works it will generally be found that the "Unit" system of planning is most economical, as by its use the initial cost of construction is reduced, and within the building the standardisation of shafting and fittings allows for alterations and growth of departments to be provided with minimum expenditure. By the term "Unit" is meant that all columns, stanchions, &c., are set out at equal distances from each other at least one way if not both (*see* Fig. 1).

The size of the unit will be controlled by the size and spacing of machines, but in general dimensions of from 16 to 25 feet will be found to be most economical. Larger units can, of course, and often must be provided; although long spans mean deep beams which may interfere with shafting and lighting, and moreover will reduce headroom; but it will be readily realised that the adoption of the unit leads to a standardisation of stanchions, beams, window sashes and fixtures of all kinds, and, therefore, tends towards economy and saving of time in the erection of the building.

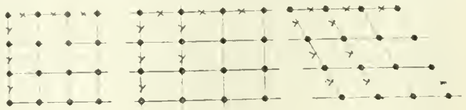


Fig. 1.

The question also of the possible growth of the business above referred to should always be considered when a building is being designed, and the wise manufacturer will cause a plan to be prepared showing the probable future development of the business. This plan will invariably save many alterations in the future, thus—heating chambers will be built large enough to receive additional boilers; stores and sanitary conveniences will have space for extensions and staircases and escape ways will be wide enough to comply with regulations affecting their use by larger number of employees, and will not be constructed in the lines of future communication.

Before, however, this general lay out can be prepared a schedule should be drawn up for both the present and future uses of the building and should contain :—

1. A synopsis of the system on which the business is carried out from the arrival of the raw material to the dispatch of the finished article.
2. The number of workers, male and female, in each department.
3. The number and overall sizes of the machines.
4. The size and details of gangways, &c.
5. Particulars and positions of foreman's and check offices.
6. The size, number and relative position of stores.

To these particulars should be added notes as to any inspection rooms, and details of any special temperatures, &c., that may be required in any of the departments.

7. Particulars of source of power proposed.
8. Particulars of laboratory, canteens, garage or any other adjuncts that may be required.

From this information, together with observations made in other works in a similar line of production, sketch plans of the lay-out may be prepared, but before any final drawings are made these plans should be discussed and analysed with both the manufacturer, works manager and chiefs of each department, as by this means mistakes that might involve heavy costs for alterations will be avoided.

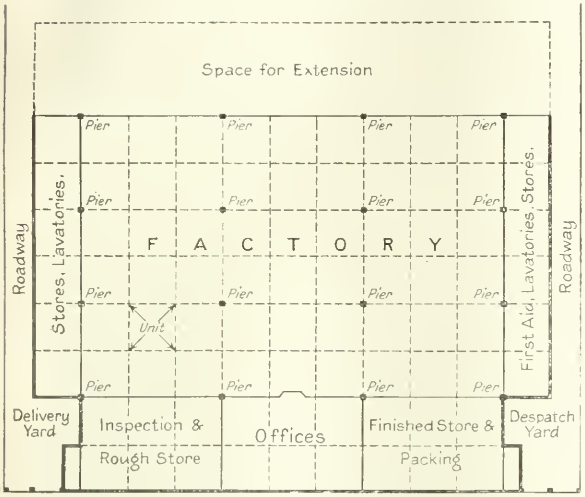


Fig. 2.

Single Story and Multi Story Buildings.

The area of the site and the trade to be carried on are the controlling factors as to whether the building should be one or more stories, but where space is available endeavour should be made to place the research buildings, canteen and club rooms outside the factory proper and with direct exits and entrances to the public road. Especially is this the case where the canteens serve as clubs for the workers after business hours, and the advantage of keeping them distinct from the manufacturing portion of premises is obvious.

Eliminating from our inquiry specialistic types of buildings, we may conveniently divide industrial structures into three classes :—(1) The building of several stories ; (2) The single story building, which is generally roofed with weaver type principals with glazing on north side ; (3) The above building with galleries around the walls or down the centre.

The building of several stories was almost universal until a generation ago when the influence of American ideas gave a great impetus to the erection of single story buildings, which could be controlled from a central office raised a few steps above the level of the factory floor.

The difficulty of moving heavy loads from one floor of the factory to another and the vibration set up by high speed machines both played their part in popularising the single story building, but the adaptability of the modern lift together with more modern methods of construction which reduce vibration to a minimum have practically eliminated these objections, and except for very delicate operations most industries can be as efficiently conducted in several story buildings as in those on one floor.

The Building of Several Stories.

This is perhaps the most useful type of structure, and where land is expensive and goods to be handled not excessively heavy will generally be preferred. Its advantages are :—

1. Large floor areas can be provided on a relatively small site.
2. Access is rapid from one department to another.

Its disadvantages are :—

1. Top lighting can only be used for the topmost story.
2. More supports, which may interfere with machinery, are necessary than in the single story building.
3. Its width is limited by the distance that natural light will carry.
4. If the site is small an appreciable percentage will be lost in lifts, staircases, escape ways, &c.

The Single Story Building.

This type can only be economically used where land is relatively cheap. Its advantages are :—

1. A uniform light is obtained over the whole area.
2. An office raised a few steps gives supervision of the whole floor.
3. Fewer supports are needed, as by forming the principals in the web of lattice girders or on deep beams spans up to 60 or 70 ft. can be obtained and factories up to 120 × 140 ft. can be arranged with but one central pier.

Its disadvantages are :—

1. The large amount of guttering necessary and the difficulty of keeping it clean, especially in districts where heavy falls of snow occur.
2. The cost of heating and ventilating is more expensive than in a building of several stories.

The Single Story Building with Gallery.

Reduced to its elements this class of structure has some of the advantages and disadvantages of each of the former types, but is specially useful where many small parts are made which must come together for assembly in the centre. All supports should be on the external walls and at edge or corner of gallery, and relatively large areas may be covered with but form supports, *i.e.*, one at each corner of gallery. Whichever type of factory may be decided upon endeavour should be made to place stores, staircases, lifts and sanitary conveniences next or outside main enclosing walls in order that the body of factory is left unobstructed.

Construction.

Except for temporary sheds it is desirable to use constructions that will reduce upkeep to a minimum, and the advantages both from the point of view of insurance and the elimination of break in production consequent upon an outbreak of fire suggest that the extra cost of fire-resisting construction is justified. The question of cost will inevitably rule out the employment of expensive building material, and we are therefore reduced to two main methods of construction.

A. The steel framed building with brick wall filling and concrete floors.
B. The building of reinforced concrete.
C. The building with brick walls and piers and steel and concrete floors.

Individual preference, the site of the building and the proximity of suitable materials and labour will all play their part in the settlement as to which system shall be used, but if A or C are used all steel work should be encased with fire-resisting materials, for, as is well known, the high temperatures generated in most big fires cause exposed steelwork to bend and twist owing both to their own and the super-imposed weights upon them.

Walls are pushed or pulled over, and the results of such movement is often greater than the damage by fire, and results in reconstruction having to be commenced at the foundations.

The walls of the building should as far as possible be considered as merely weather-resisting or lighting surfaces, and all weights should be concentrated upon a series of piers which should project outwards rather than into the factory. For the internal supports reinforced concrete piers will, of course, occupy more space than steel stancheons, but the saving in cost of construction will compensate for this, and when the increased area taken by the steel encasement is added to the stancheon the difference is often found to be small. In all cases the edges or square piers should be taken off, giving a play of at least 1½ in. across.

The construction of floors must be governed by the trade to be carried on, but in the choice of finishings it should be remembered that traffic is generally heavy on factory floors, and the cost of maintenance should be allowed for, as a somewhat more expensive initial cost is often justified in a few years.

For the roof coverings many new materials have been recently introduced, but until time has tested them we would suggest that slates or tiles should be used for slopes and asphalte for flats.

Elevation.

The monotony of the average Victorian factory is apparent to every one, and, moreover, when money was allowed for the elevations, ornament and detail that would have been just as well suited to a bank or small public building were often wrongly employed.

In the modern factory the result of concentrating all weights on regularly spaced piers gives a structural basis which is of itself architectural, and the emphasising of these and the beams tying them together will lead to an impression of power and dignity that can only otherwise be obtained in large city or public buildings.

Ventilation and Heating.

Of the two the former is by far the more important, as in many trades the work carried on renders heating unnecessary. Ventilation has for its object the removal of the vitiated air, and its replacement by air which has been defined as: Air which is pure and clean for the workers to breathe, and an atmosphere that is both stimulating and refreshing. This second requirement has been far too often overlooked, and the fact that chemically pure air may tend to enervate and depress those breathing it has been proved by experiments.

When a factory has been left empty for a considerable time and where the air is relatively pure, no sooner is work commenced and machines started than various impurities can be traced, chief of which are: (1) Carbonic acid gas; (2) Various ill-defined volatile substances arising from human beings, especially where personal cleanliness is lacking and perspiration is profuse; (3) Bacteria; (4) Dust and fumes and impurities given off from the process of trade.

Of these it is probable that bacteria are the most potent form of impurity, which must be removed, and the recent epidemic of influenza has provided instances where organisms passed from one department to another until the closing of the whole works became a necessity. Suggestions have been made that if a greater volume of space was provided for each worker ventilation would be unnecessary, but modern industrial conditions veto the possibility of using half measures to solve the problems on which the working of the factory depends, and it is axiomatic that space must not be wasted if efficiency and co-ordination of works are to be maintained. Apart from this, however, large masses of stagnant air are often found in many shops where few workers are employed, and its presence has been found to lead to feelings of depression and fatigue, with a consequent lowering of production.

In short, the desirable atmosphere for the factory may be said to be cool, tending to dryness, with movement to prevent stagnant patches, and fluctuating about the desired mean temperature which will depend on the uses of the building.

The work carried on does in certain cases control the temperature and humidity of the atmosphere, and in such cases methods of control within fixed maximum and minimum limits must be placed in charge of a responsible person, but generally for normal works the following will be found to be safe guides:—

For heavy manual labour	44–48°F.
For heavy labour at machines	46–50°F.
For light labour at machines	50–54°F.
For sedentary work	58–64°F.

The methods by which factories are ventilated can be conveniently divided into three classes: (1) Those by which air is forced into the building and allowed to find its way out; (2) Those in which the vitiated air is withdrawn, inlets being provided for its admission; (3) Those in which air is both forced in and withdrawn. Which of the three shall be used will depend on the uses of building, and the money to be expended, but in every case some system of ducts is necessary to ensure perfect ventilation.

The most effective method of heating and ventilating is by means of the "plenum" system by which the air is drawn through a filter into a chamber and warmed in winter and cooled in summer, after which it is driven by fans through ducts to every part of the structure. With this system no other method of heating is required, but the upkeep charge is heavy and cheaper and fairly effective heating and ventilating may be provided by the provision of a system in which air is admitted behind radiators or coils of pipes and outlets provided into a duct fitted with exhaust fan.

Wherever lantern or overhead lights occur hot water pipes should be run around their base in order to prevent the formation of cold masses of air, which set up draughts which inconvenience those working below them.

In addition to the general ventilating scheme provision should be made for removing all fumes and dust at their source, and all machines causing dust should be fitted with hoods placed to intercept both the dust thrown from the wheels or work, and also that which would naturally fall to the floor. These hoods should be connected with a duct along which a powerful current of air is passing, and the duct itself should finish in a tank or pit outside the building in order that no contamination is caused to the surrounding atmosphere.

Lighting.

In dealing with the lay-out of the building it was suggested that the outside walls should be merely weather resisting or lighting surfaces, and if the windows are made as large as possible the result will be what is termed the "daylight" factory. Its advantages are that accidents will be lessened, production will be increased, and the cost of providing artificial light will be relatively small.

The choice of glazing material is more difficult than appears at first sight, for if a window receives direct sunlight the flood of intense light through clear glass is apt to cause more eye strain to a worker near it than would be occasioned by working in a dimly lighted room. What is required is a glass that possesses a reasonable degree of constancy and uniformity of illumination, and this can be most economically obtained by using ¼ in. ribbed plate cut so that the ribs run horizontally across the panes.

The Sanitation of the Factory.

All sanitary conveniences should be separated from the work rooms by ventilated lobbies. All floors should be of impervious material laid to a slight fall to glazed channels or gulleys, so that any water that may be spilled on them will drain away, and so that no possibility exists of the formation of pools of water on the floor. A stand pipe with length of hose should be provided in order that the floors may be washed down and squeegeed at frequent intervals. The walls should be lined with glazed bricks, and the junctions of floors with walls made to a slight curve, also all corners should be rounded. The divisions between w.c.'s should be of material that can be washed down, and if they are raised a few inches from floor greater cleanliness is obtained. In all lavatories hot and cold supplies should be laid on to allow for buckets to be filled without resting them in a lavatory basin. Both in the lavatories and in the factory facilities for obtaining drinking water must be provided direct from the main.

Painting, &c.

The finish of the rooms will play an appreciable part in the lighting of the factory and will also tend to raise or depress the spirits of the workers, and for this reason it will be found beneficial to carry out simple schemes of colour. Dark colours absorb natural light whilst light ones reflect it, so that and, therefore, for the walls pale shades of yellow green or grey should be used. The ceilings should be white, and where indirect lighting is used the extra cost of enamelling will be repaid by the greater reflecting power obtained.

Industrial Lighting as an Element in Mass Production.

By LEON GASTER, F.J.I.
(Editor of the "Illuminating Engineer.")

THE case for good industrial lighting in factories may be stated on three main grounds, *i.e.*, in the interests of (*a*) health, (*b*) safety, and (*c*) efficiency. These three factors apply to industrial lighting generally, but in the case of "mass production," as will be seen, the part played by proper industrial lighting is, if anything, even more important than in others.

Lighting as an Element in Mass Production.

Mass production tends to accentuate the importance of good illumination. The introduction of a three-shift system, as Lord Leverhulme has suggested, would enable more work to be done with an available factory and plant, the latter being operated to its fullest extent by successive gangs of workers. But naturally the system assumes that a much larger proportion of work is done by artificial light. Theoretically there is no reason, in most factories, why work should not be executed with the same efficiency by artificial as by natural light. Indeed, artificial light, being so much more fully under control, ought to be more readily adaptable to the needs of any particular industrial operation. But hitherto in many factories results have not been so good by night as by day. Thus the investigations of the Home Office Departmental Committee showed that in most industries the accident rate by night was greater than by day, and a case was recorded in which the output by artificial light was 12 per cent. less than by daylight. If the full benefit of the multiple-shift system is to be obtained, therefore, it is essential that the artificial lighting should be scientifically designed and fully adequate.

Where automatic machinery is much used, good lighting is of special significance, because such machinery, being often more complicated, requires careful supervision. Poorly lighted plant is rarely properly cleaned, its efficiency is diminished, and ultimately there may be a breakdown, with a correspondingly serious effect on output. Again the standardisation and interchangeable nature of parts, where aimed at, involves very careful workmanship and accuracy, such as is only possible when the operators enjoy good illumination. Once the machine is set by a skilled operator it may turn out automatically large quantities of work, with little attention. But an initial error in the accurate setting, such as may easily arise if the workmen cannot see clearly the tool he is adjusting, may result in a large output of faulty material before the mistake is discovered.

Next it has to be remembered that the essence of the mass-production system is that the manager should be able to oversee the whole process, to direct his attention in turn to each step in the chain of operations, and he can only do this successfully if there is good general lighting available, and if the lighting system is so contrived that there is no interference with his view of the shop Finally, it must not be overlooked that a system of production which consists of a chain of operations, each part being successively treated and handed on for the next process, depends for its success on each stage being executed not only accurately and correctly, but in a prescribed interval of time. Inadequate lighting at any point in the chain of operations may produce a local check or stoppage, which at once slows down the process as a whole.

Influence of Improved Lighting on Efficiency.

While the general advantages of good lighting in improving the efficiency of work, both by accelerating output and in preventing spoilage of goods, are becoming well recognised, it is less easy to obtain data showing the actual economic gain in pounds, shillings and pence.

Common experience, however, fully justifies the belief that good lighting has a direct effect on efficiency of work, as well as the indirect advantages arising from the better health, comfort and safety of workers. When once an improvement in illumination has been made in one section of the works employees in neighbouring departments are quick to agitate for a similar change in their section. Moreover, when once an improvement in lighting has been made, neither management nor staff desire to return to the old conditions. The views of workers on this point are likely to be particularly influential in "mass production" for it seems likely that in the future this will involve, to a great extent, payment by results. It has been recorded that in the north of England workers, paid by piece work, tend to migrate to the better lighted mills.

Some specific instances of the effect of lighting on output were given by witnesses before the Departmental Committee on Lighting in Factories and Workshops. Thus in one case the earnings of workers increased 11·4 per cent. after better lighting was installed.

A striking series of experiments has also been undertaken by the Commonwealth Edison Company in Chicago, which (like other supply companies in the United States) supplies lamps and fittings as well as electricity and is thus in a good position to keep records of changes in lighting arrangements and survey any possible improvements in output resulting. The tests conducted related to 93 factories with a total staff of 17,400 employees. The existing conditions of illumination were first studied and it was found that the average illumination was 1½ foot-candles, corresponding with a consumption of 0·33 watts per square foot. The amount of illumination provided varied within somewhat wide limits, namely, from 0·01 to 10 foot-candles, whereas according to the standards of the American Illuminating Engineering Society the variation in illumination, according to the nature of the work carried out, should have been 2 to 12 foot-candles, and the average recorded 5·5 foot-candles. The conditions of illumination were thus considered inadequate, on the whole, as regards the amount of light provided, and there were also defects as regards nature of fittings, presence of glare, &c. A programme of experiments was then drawn up as follows, covering four months. The first month was to run with the existing lighting. The second month with rearranged lighting and a value of illumination 50 per cent. in excess of that required by the American Illuminating Engineering Society's code, the third month at the lower code level, and the fourth month again at the higher illumination.

Tests are recorded on 11 plants, and although it was not always possible to induce manufacturers to proceed with the full experiment, enough was done to demonstrate some remarkable improvements in output. Thus in one case the increased production in different departments ranged from 8 to 27 per cent., when the illumination was increased three times, *i.e.*, from 4 to 12 foot-candles. In another case (where the original lighting was clearly quite inadequate and the illumination was increased no less than 25 times) increases in output from 30 to 100 per cent. were noted. Taking a very conservative view of the situation the conclusion was drawn that *an increased cost in lighting amounting to not more than 5 per cent. of the pay-roll would in general lead to an increased production of quite 15 per cent.*

These results are very striking, and while one would like to see confirmatory tests in this country, they suggest that the economical limit to the amount of illumination provided (*i.e.*, the limit beyond which any increase in illumination leads to no advantageous gain in efficiency of production) may be much higher than is commonly supposed.

Cost of Lighting in Relation to Total Costs of Production.

At this stage it may be desirable to say a few words on the relation of cost of lighting to total operating costs. Naturally the proportion which cost of lighting bears to the cost of production varies in different industries. It is probable that in the great majority of cases the cost of lighting forms little more than 1 per cent. of the wages bill, and it will thus be seen how easily even a small improvement in the efficiency with which work is done may more than compensate for the slightly increased cost of better lighting. Yet improved conditions of lighting do not necessarily involve extra cost. In many cases, where light is being wasted by the injudicious use of the available lamps, or where obsolete and inefficient lighting appliances are being used, a slight rearrangement of the conditions may give the illumination desired, without any addition to the lighting bill, or even with a reduction.

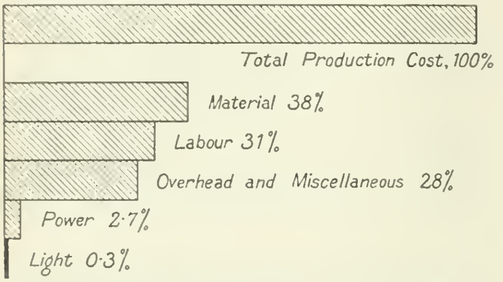


Fig. 1.—Diagram Showing Distribution of Working Costs in a Machine Shop.

Lighting forms less than 1 per cent. of the wages bill.

The above diagram (Fig. 1), which is based on some data acquired for a large machine shop in the United States by Prof. C. E. Clewell, shows in a striking manner how small a fraction (in this case less than 1 per cent.) lighting forms of the total costs of production. Similarly costs of installation commonly form a very small part of the total cost of equipment. Thus in the American Ford Motor Works, which are essentially conducted on mass-production principles, Prof. Clewell found that the total cost of equipment and buildings was about 6s. 6d. per square foot of floor area, and the lighting costs approximately 2½d., *i.e.*, 3 per cent. of the total.

Fundamental Principles of Good Lighting.

The fundamental principles of good industrial lighting were clearly stated in the Report of the Departmental Committee on Lighting in Factories and Workshops, as follows :—

1. Sufficient illumination over the working area. .
2. Reasonably uniform illumination over the working area.
3. The placing and shading of lamps in such a manner that the light does not fall directly into the operator's eyes when at work,
nor when looking horizontally across the room.
4. The placing and shading of lights in such a manner as to avoid casting inconvenient extraneous shadows on the work.

It will be noted that the mere provision of *sufficient* illumination on the working area is not in itself enough to secure good lighting. The avoidance of glare and inconvenient shadows are at least equally important.

While these fundamental principles ought always to be complied with, it is obvious that the exact requirements of lighting in any factory can only be fully appreciated by one who is both familiar with the principles of illumination, and conversant with the nature of the processes carried on. It is, however, possible to state in general terms the amount of illumination broadly necessary for different classes of work, and the following schedule may be put forward tentatively as indicating good modern practice :

Illumination Required for Various Purposes.

Nature of Work.	Minimum Illumination (Foot-candles).
In passages, store rooms, &c., and places where illumination is only needed in the interests of safety and general convenience	0·25
Very rough work, not involving close inspection, but only the handling of large objects	0·5 to 1·0
Rough manufacturing operations, such as assembly, bench work, &c., and very simple clerical work	2·0 to 3·0
Fine manufacturing operations	3·0 to 5·0
Very fine work (such as engraving, accurate metal work, special draughtsman's work or work on dark materials)	5·0 to 10·0

It is to be observed that these are suggested *minima*, and it may well be that in many industrial operations they might be exceeded with economical advantage. A point to be specially noted is the influence of the colour of the material. Tests at the National Physical Laboratory have shown that the product of the necessary illumination and the coefficient of reflection of the material, *i.e.*, the *surface-brightness*, is roughly a constant for efficient conditions of work. Sewing dark cloth with black thread is regarded as one of the most trying and exacting operations for which a specially high (usually local) illumination is needed. On the other hand, when working with very light surfaces, and especially surfaces of a polished or semi-polished nature, great care must be taken to avoid glare due to excessive direct reflection of light.

Important Features in Modern Industrial Lighting.

Finally, a word may be said regarding modern tendencies in industrial lighting, with special reference to mass production. While it is not possible to draw any hard and fast line between so-called general and local methods of lighting, there is no doubt that the tendency is now towards illuminating the room as a whole by judiciously distributed efficient lamps and reflectors, placed high up out of the range of view. This overhead system of lighting, besides being conducive to avoidance of glare, has the important advantage of leaving a clear space, unobstructed by pendant fittings, which enables the manager to survey the room as a whole, and greatly assists

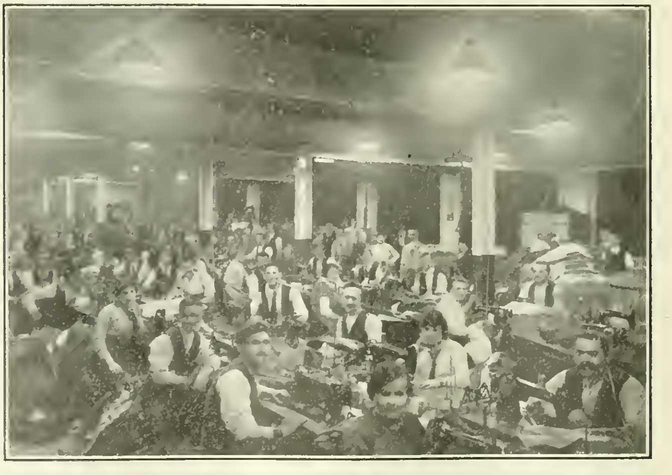


Fig. 2.—Overhead Lighting with Gas-filled Lamps in a Modern Clothing Factory.

Consumption, 0·75 watts per square foot. Average illumination, 7-10 ft.-candles. This method is suitable when fairly light materials are used, but for work on cloth of a very dark texture a combination of general lighting with well-shaded local lights is now considered advisable.

supervision. Some examples of this method, which is specially adapted to rooms containing a large number of workers engaged on similar operations side by side, are illustrated. The introduction of the gas-filled ("half-watt") lamp has contributed towards the development of this method, the height of suspension being in some cases as great as 30 or even 40 ft. It should hardly be necessary to point out what a very important part scientifically designed reflectors, such as are made by several leading firms, play in lighting of this nature. On the choice of such reflectors, and the selection of correct spacing distances, the securing of good uniformity of illumination and the avoidance of inconvenient shadows depend. Another point of great consequence is the maintenance of light surroundings, white ceiling and light tinted walls, which aid very greatly in diffusing the light and preventing awkward shadows. So well is this realised that in some cases portions of machinery are whitewashed in order to prevent troublesome shadows at the point of the tool.

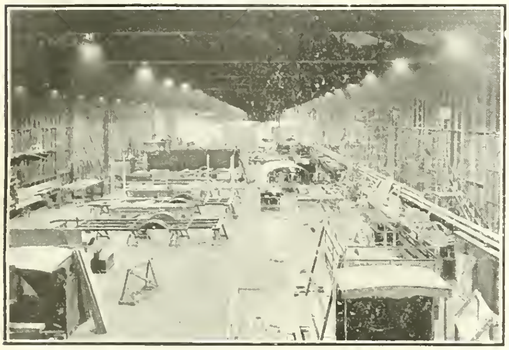


Fig. 3.—Erecting Shop, Devoted to Aeronautical Engineering, Lighted on the Overhead System with Gas-filled Lamps and Holophane Industrial Type Reflectors.

Illumination, 3·5 ft.-candles.

On the other hand, cases also arise where it is preferable to provide local lights, specially situated with respect to the work carried on. For example, small 10 or 12-volt lamps fed from small transformers at various points in the shop, each serving a group of machines, and brought very close to the tool worked with, have been used, the wiring being very simple by reason of the low voltage. By using a suitable reflector (a very vital matter when lamps are brought as near the work as 15 in. or 18 in.) an illumination of 15 foot-candles can be easily secured, so that the method is well adapted to exceptionally fine work. In all such cases two points require careful attention, (*a*) the local lamps must be efficiently screened from the workers' eyes, and their position with regard to the work very carefully selected, (*b*) in order to avoid excessive contrast between the brightness of the brightly lighted local area and the surroundings, a moderate amount of general illumination must also be provided.

Cases also occur in which special local lights are needed to enable cavities to be examined (*e.g.*, in shell-making), a condition which is easily met by the use of portable small lamps, as a supplement to general illumination. It is sometimes urged that exceptional local illumination is desirable for the purpose of inspection of parts which require very careful manufacture. While it is true that for purposes of inspection good illumination is essential, it may be suggested that it is not fair to the worker to expect him to turn out material by an illumination much inferior to that under which it is judged, if the amount of light he receives for working is inadequate for the detection of faults.

Maintenance of Industrial Lighting.

Finally, a word may be said on the importance of maintaining a lighting installation in good condition. In any works that aims at mass-production, systematic examination should present no great difficulty, even though the number of lighting units may be considerable. Tests have shown that when lamps and fittings are neglected for several months a loss of quite 50 per cent. in the original illumination may readily occur, and cases are on record in which, by merely cleaning lamps and reflectors, and replacing parts that are damaged or worn out, the available illumination has been at once doubled. The cost and trouble involved in organising a staff for maintaining lighting fittings is more than compensated by the economic value of the light saved, and this matter should be regarded as an essential part of the whole system of upkeep of machinery which, it need scarcely be said, is vital to efficient mass-production.

Output Planning.

A Factor in the Elimination of Waste.

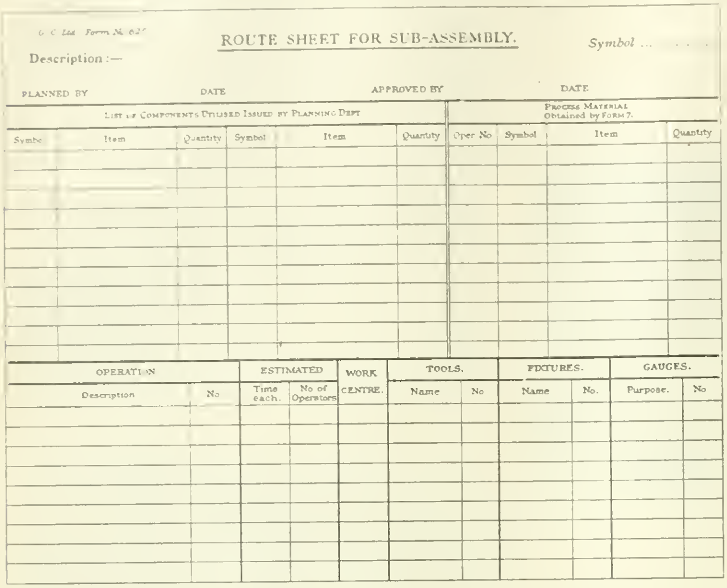
By A. ROBERT STELLING, A.M.I.E.E.
(Industrial Engineer and Organiser. Member of the Manchester Engineering Council.)

Faced with an enormous demand for commodities and a real need for increased output on the one hand, and with a shortage of raw materials, a deficiency of real skilled assistance and a reluctant labour force on the other hand, the manufacturer of to-day has come to realise that his only hope of success lies in intensive production methods and improved organisation. The enhanced value of labour due to shorter hours and higher pay, the enhanced value of materials due to adverse exchange and real scarcity, compel the manufacturer to enter on a campaign for the elimination of waste, such as he has never before contemplated. He realises that his policy of management must be overhauled in the light of recent experience and of present exigencies if he is to be successful at all in increasing the output of the factory. He can no longer allow old-fashioned haphazard methods to obtain, nor can he expect to control his intensive campaign by his personality alone, aided by a more or less reliable memory. It behoves him to consider, in the first place, the elements of management itself in order to determine the actual steps to be taken in the development of his policy.

The Functions of Management.

Considered in its simplest form, management has three functions—to plan, to direct, to examine results. No matter how large or small a concern may be, here are the elements. In a factory the function of examining or of "controlling" is carried on by the aid of the cost accounting department; "directing" by the aid of foremen. But planning has not been recognised as a separate function, it has usually been left to each individual to plan for himself (in effect an ill-considered devolution of function) or ignored entirely. Who would think of expecting foremen to supply "control" reports, that is to say, submit the final or analysed cost figures? But is it not just as necessary to think ahead, to predetermine policies and processes as to control and examine subsequently the results of action taken? Therefore, planning should be considered just as much a separate function of management as cost accounting and treated as such.

Once this triple division of functions is realised it will be observed that planning goes on in every corner of the factory. Hence a planning department steps in to concentrate in one department and render more efficient (through co-ordination and specialisation) such planning as is clearly the function of the higher management and which takes up the time and over-burdens those individuals upon whom it has incorrectly devolved, leaving them free to direct or to control as may be their function. The planning department will not take upon itself the planning which each individual must do for himself to run his own department.



G C Ltd Form No. 62

ROUTE SHEET FOR SUB-ASSEMBLY.

Symbol ...

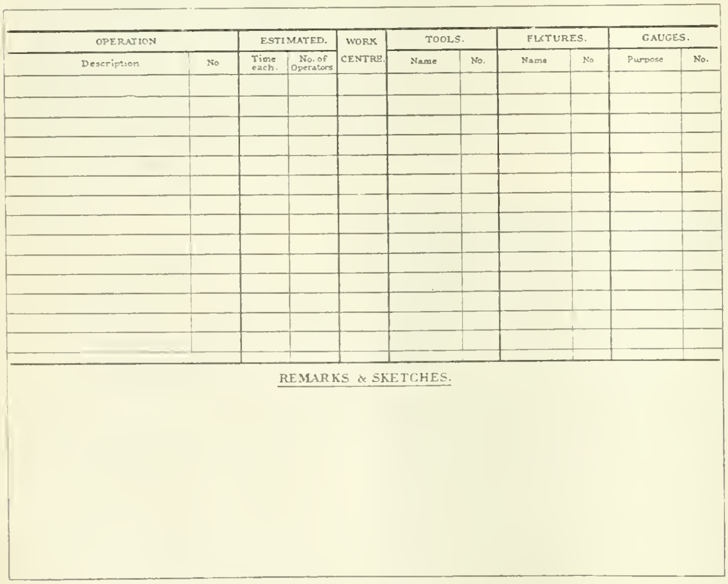
Description :—

PLANNED BY DATE APPROVED BY DATE

List of Components Utilised Issued by Planning Dept						Process Material Obtained by Form 7.			
Symbol	Item	Quantity	Symbol	Item	Quantity	Oper No	Symbol	Item	Quantity

OPERATION		ESTIMATED		WORK CENTRE.	TOOLS.		FIXTURES.		GAUGES.	
Description	No	Time each.	No of Operators		Name	No	Name	No.	Purpose.	No

Fig. 1 (Front).



OPERATION		ESTIMATED.		WORK CENTRE.	TOOLS.		FIXTURES.		GAUGES.	
Description	No	Time each.	No. of Operators		Name	No.	Name	No	Purpose	No.

REMARKS & SKETCHES.

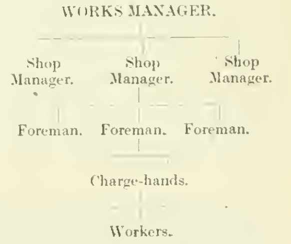
Fig. 1 (Back).

The Planning Department General Staff.

The planning department is to the works-manager what the general staff is to the Commander-in-Chief. Consider what takes place when an attack is ordered. The general plan of attack and the objective are decided upon by the General; reports are obtained from battalion commanders as to local conditions and then the detailed plan is worked out by the staff. The battalion commanders are then called in to discuss this plan, after which the staff get busy with preparations and accessory arrangements. Finally, at zero hour, the attack is launched, and *if the staff work has been good*, the attackers are well provided with maps, ammunition, rations and other supplies both at zero hour and at every succeeding stage of the attack.

Just imagine the confusion that would occur and the lack of co-ordination between the various arms or battalions if each colonel were left to work out his own arrangements. The detail would over-burden him and interfere with his principal duty, the supervision of the personal preparations of each man and the direction of each phase of the attack in consonance with the plan agreed upon.

Now let us apply this analogy to a factory. The General is the works manager or superintendent; his objective is output; the battalion commanders, the men who lead the attack, are the foremen, the "chain of command" or "line organisation" being this:—



(Shop managers only in the case of very large works.)

The plan of attack is the output programme, the maps are the drawings and material schedules; ammunition may be represented by jigs, tools and gauges; rations and stores may be considered the general conditions of work and supplies.

The Functions of the Staff.

It is the function and duty of the staff, that is to say of the planning department, to provide all these accessories to the foremen at each stage of the attack, that is to say during the whole of the production period. The analogy may be carried still further, for the planning department will requisition new and special machinery to replace worn-out or obsolete "ordnance," and will (through the employment branch) provide reinforcements of labour to deal with increase of pressure—in our case this means meet demands for increase of output.

Actually then the work of any planning department in any factory will include the following steps :—

1. "Routing."—To determine the one best way (for the factory) to effect the manufacture of the commodities desired.

2. "Tool Planning."—To make provision for this manufacture by placing on order the tools and appliances necessary thereto.

3. "Material Allocation."—To always know what material is in stock and by advance allocation and requisitioning ensure that supplies of raw material are forthcoming when required.

4. "Despatching."—To place the raw material in work at such times and in such sequence that the final assembly or shipment takes place to scheduled date.

5. "Rate-setting."—To determine the scale of reward for performance of the manufacture in accordance with (1).

6. "Scheduling."—To maintain a current record of work ahead in order to give reliable output promises to the board for future orders.

7. "Co-ordinating."—Generally to co-ordinate the manufacturing departments with each other and with the stores, buyer, cost office and service departments, as well as with the sales and outside departments (where such exist).

The actual procedure of a planning department will naturally vary with the manufacturing policy and product. Planning for single unit manufacture must be different obviously from the planning for the output of roller chains or the finishing of woven fabrics. Certain principles exist, however, which are common to all branches of manufacture and their development in more or less elaborate detail depends upon the volume and nature of the output. Few firms in the electrical industry are in the happy position of being able to manufacture solely one or two standard lines throughout the year, with machine tools specially set up for one operation only.

This would be real mass production, but intensive production of a very considerable number of lines is possible with the aid of a well-organised planning department. In dealing with the detail of planning, the case will be considered of an average works producing complete units, which are formed by the assembly of standard components in varying groupings and quantities. This is the most complicated case, involving every phase of procedure, and the details can be worked out from it for other cases.

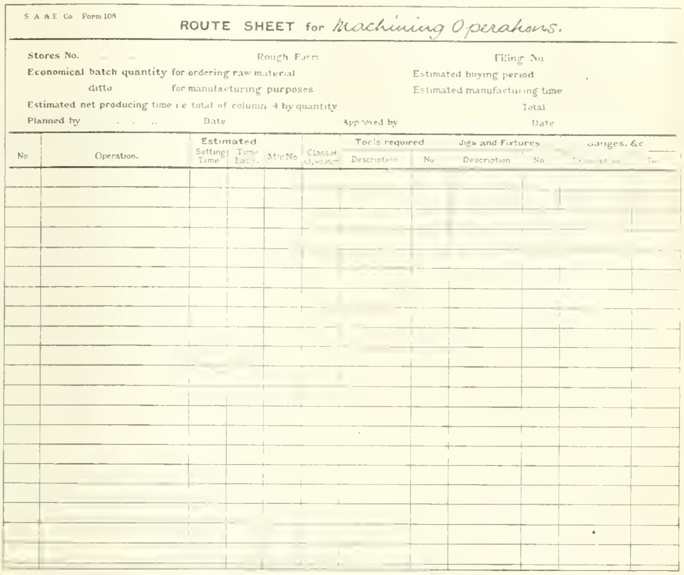
THE PRINCIPLES OF PLANNING.

The principles which underlie all output planning are these :—

1. There must exist, or be prepared, a census of all machinery and appliances in the factory, and of their capacity. This census when made will bring to light numerous causes of inefficiency, which it is the duty of the management to remove immediately.

2. Technical data of the speeds, temperatures, &c., at which the material can be worked, and of past performances of individuals, must be recorded and tabulated.

3. The movements of the purchases and stocks of production material must be under the control of the planning department. This presupposes a modern storage system.



S A & E Co Form 108

ROUTE SHEET for Machining Operations.

Stores No. Rough Form Filing No

Economical batch quantity for ordering raw material Estimated buying period

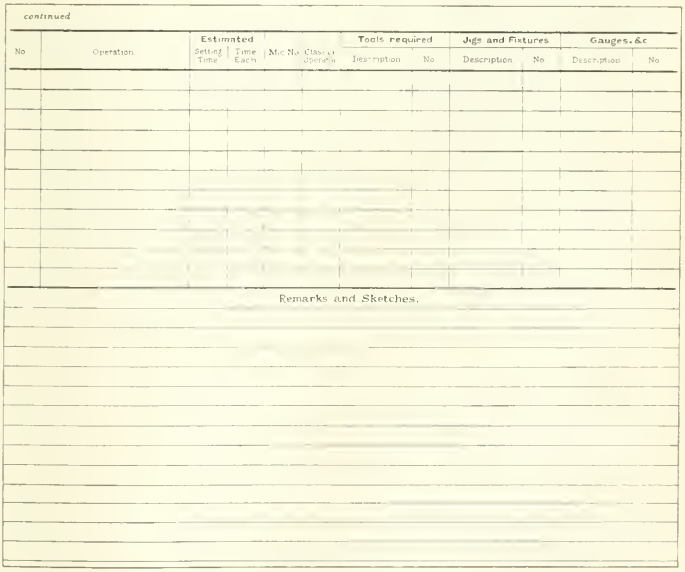
ditto for manufacturing purposes Estimated manufacturing time

Estimated net producing time i e total of column 4 by quantity Total

Planned by Date Approved by Date

No	Operation.	Estimated		M/c No	Class of Operator	Tools required		Jigs and Fixtures		Gauges, &c	
		Setting Time	Time Each			Description	No	Description	No	Description	No

FIG. 2 (FRONT).



continued

No	Operation	Estimated		M/c No	Class of Operator	Tools required		Jigs and Fixtures		Gauges, &c	
		Setting Time	Time Each			Description	No	Description	No	Description	No

Remarks and Sketches.

FIG. 2 (BACK).

Space necessitates the assumption that these principles are accepted and are put into practice. Their acceptance is the acceptance of the principle that good management is based upon knowledge of facts.

Fortified with the foregoing exact knowledge, the planning department is now ready to proceed with its campaign of intensive production. Most forms of production of electrical goods are those in which "manufacturing" processes predominate as contrasted with the "assembly" processes in machine tool or motor-car manufactures where units are built up by a series of grouping of components, and the combination of increasingly complex sub-assemblies. It is true that assembly work does take place almost universally, but such is its nature that it can be regarded in many cases as a manufacturing operation. Thus the assembly of circuit breakers, the winding of armatures, the building of cores, can all be standardised and their consideration as manufacturing processes should be insisted upon, followed by as close a study as machining operations undergo.

The Route Sheet.

Special attention will therefore be given to manufacturing processes. Whether these be assembly or machine work, the basis of these is the "Route sheet." Samples of these for both classes of work are given in Figs. 1 and 2. The engineer responsible for this work must be a most carefully chosen and trained man. He is the man who, in consultation with the foremen, determines the "one best way." His time estimates form the basis for the progress schedules and also for the piece-work or bonus rates. His route sheets determine the machine engagements, the control of the order to work, and they also control the cost summary. Hence the importance of this man's work. The idea of predetermining the machining processes and ordering the jigs required is, of course, generally accepted; the procedure of properly tabulating the sequence of operations, together with a *complete* list of jigs, tools and gauges required, only obtains in very few factories, and the idea of carrying out the same procedure for assembly work exists hardly at all. But it is every whit as important to predetermine assembly methods The route sheet should be made out, appliances listed (and subsequently designed) and all preparation made beforehand, just as if a machine were to do the work instead of a human being. The problem in appliance design is, of course, the saving of labour and elimination of unnecessary fatigue.

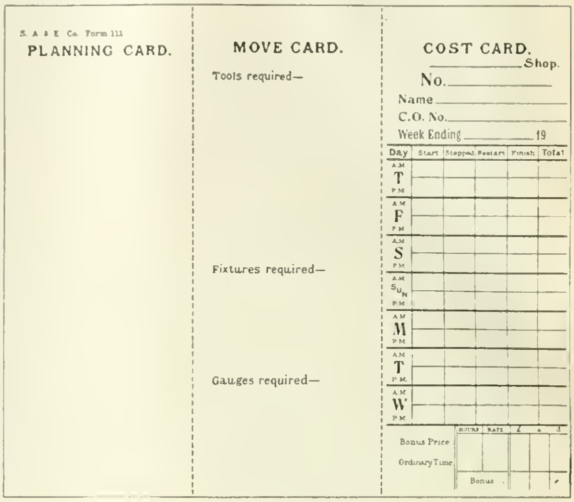
In allocating a process to a definite machine or to an assembly centre or vice, the amount of work ahead of that particular unit must be considered, and if necessary other methods of manufacture be adopted to preserve balance of plant, alternatively extra equipment placed on order. A simple bar diagram with date abscissæ enables this allocation to be performed with accuracy.

The method of moving material and putting work in hand as applied by a planning department is quite different to that of an old-fashioned "progress department," in that the latter extracted promises from harassed foremen and "chased up" the work. The planning department sets its own promises and moves the work to suit these, taking all this worry off a foreman. The foreman is responsible for the *individual* output of each man, the planning department is responsible for the *combined* output of the factory.

The Method of Control.

The method of control is a combination of planning board and charts. Still considering intensive diverse production (which is the more difficult to plan, and on which planning for uniform mass production is based), we will assume that work goes through in fairly large batches; each of these batches will bear an order or lot number. A component order or assembly order will, therefore, be made out, the first for the manufacture of each component up to its delivery to the finished parts stores, the latter for the grouping of so many sets of components. The procedure is then identical in principle. The component order (C.O.) is made out from the route sheet, and from the C.O. are made out the detail cards. These are threefold, and comprise planning card, move card, and cost card, and one is made out for each operation (Fig. 3). The planning board (Fig. 4) has a set of four pockets for each machine number or assembly centre. The cards (Fig. 3) are placed in the lowest pocket which is for "work ahead," the machine number on the card, taken in directly *via* the C.O. from the route sheet, showing where it is to be placed. The detail cards for "first operations" (*i.e.*, the first work done on withdrawing the rough form from the stores) bear distinguishing clips.

As material becomes available, the "first operation" cards for work on that material are moved up into the third pocket on the board. This is the "work ready" section. Cards for second and subsequent operations are moved into the "work ready" section as and when the articles from the corresponding first or preceding operation are received in the work exchange and passed by the inspector. The second pocket is for work "at" the machine, and the first or top pocket is for work "on" the machine. These pockets are only large enough to take one card each.



S. A & E. Co. Form 111

PLANNING CARD.

MOVE CARD.

Tools required—

Fixtures required—

Gauges required—

COST CARD.

__________ Shop.

No. __________

Name __________

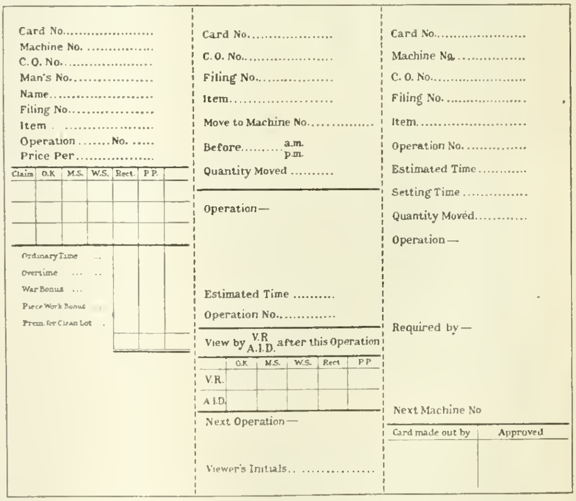
C.O. No. __________

Week Ending __________ 19

Day	Start	Stopped	Restart	Finish	Total
A.M. T P.M.					
A.M. F P.M.					
A.M. S P.M.					
A.M. SUN P.M.					
A.M. M P.M.					
A.M. T P.M.					
A.M. W P.M.					

	Hours	Rate	£	s	d
Bonus Price					
Ordinary Time					
Bonus					

Fig. 3 (Front).



(Cost Card.) (Planning Card.)

Card No.....................

Machine No. ....

C.O. No.....................

Man's No....................

Name.........................

Filing No....................

Item ....

Operation ....No. .....

Price Per....................

Claim	O.K.	M.S.	W.S.	Rect.	P.P.	

Ordinary Time ...

Overtime ... ...

War Bonus ...

Piece Work Bonus

Prem. for Clean Lot

Card No.....................

C.O. No.....................

Filing No....................

Item..........................

Move to Machine No...............

Before.......... a.m. p.m.

Quantity Moved ....

Operation—

Estimated Time ....

Operation No..............

View by V.R. A.I.D. after this Operation

	O.K.	M.S.	W.S.	Rect.	P.P.
V.R.					
A.I.D.					

Next Operation—

Viewer's Initials.. ....

Card No.......................

Machine No. ....

C.O. No.......................

Filing No. ....

Item...........................

Operation No. ....

Estimated Time ....

Setting Time ....

Quantity Moved...........

Operation—

Required by—

Next Machine No

Card made out by	Approved

Fig. 3 (Back).

When the operation represented by the card in the top pocket is completed, the card is taken away and the card immediately below it is moved up into its place. This means that the next job, which was waiting at the machine, has been put in work. The cards in the "work ready" pocket are now examined and the most urgent job selected. The "planning card" is torn off and placed in the second pocket, the cost card sent to the time office ready to be clocked on when the job is started, and a labourer takes a requisition for the material to the stores or the work exchange. This material is placed conveniently near the tool and the move card is handed by this labourer to the foreman. On the reverse is a list of the equipment he requires, and this he obtains from the tool-room in time to start the next job. Meanwhile, the work "on" the machine proceeds and is finished. The man clocks off his corresponding card, clocks "on" the new one referred to above and starts work without loss of time on the next job, all tools and material being ready to hand. The foreman sends the work to the viewer and the move card to the planning office. The corresponding planning card is removed from the top section, and the next operation card is moved from the fourth pocket to the third of the tool on which the next operation is to be performed. The process goes on until the components finally come to rest in the finished part stores, when the C.O. is closed out and the master card sent to the cost office for costing.

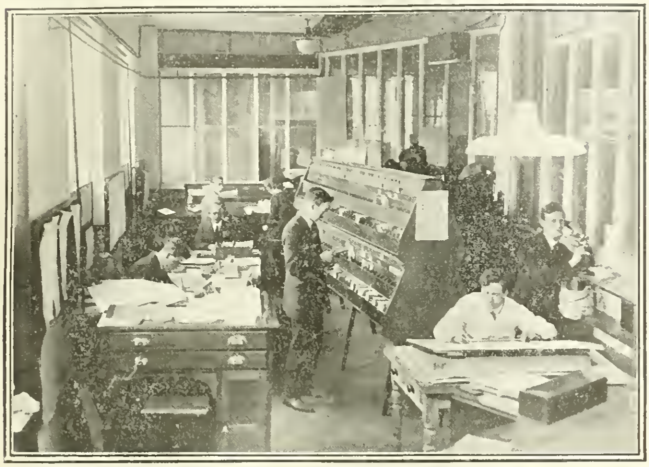


Fig. 4.—Setting up the Planning Board.

In selecting cards from the third pockets the relative urgency of work is determined by the visual control afforded by charts. These charts, for components, show material available, quantities put in work, quantities received complete and quantities issued for assembly, thus with the aid of date planning lines the position of any component can be visualised in a moment. For assembly, the bars for each sub-assembly will indicate number of complete sets in stores, numbers of sets put in work number of sets complete and number of sets sent to next, assembly operation (or sent to the shipping department).

From the foregoing it will be seen that it is possible to control every item of manufacture from a central office. The most obvious advantage is the prevention of loss of time by providing all appliances beforehand, by always having a selected job ready—no waiting time, by insisting upon careful study of a job, such as must be done if a route sheet is to be of any value, and so getting it done properly instead of "muddled through." On the assembly side it prevents work being started for which all items are not available and provides possibilities for speeding up production to meet such shortages.

The great advantages which will develop are, firstly happier foremen—relieved of the worry of chasing, requisitioning and promising, hence more efficient. Next, reliable promises for completion, *increased rapidity of turnover,* and finally reliable data for the formation of policies by the manager and his directors.

The cost of such a department is negligible compared with its results, but in organising it care should be taken to obtain the best advice and personnel available.

Costing.

Some Phases of Modern Cost Finding with Particular Reference to the Manufacture of Electrical Apparatus.

By REGINALD TOWNSEND, A.C.A.
(Works Accountant, Metropolitan-Vickers Electrical Co., Manchester.)

In the days of the small manufacturer, who personally controlled all the manufacturing details of his business, the need for costing was not felt to any considerable extent, but with the advent of Joint Stock Companies and the rapid growth of large factories the personnel of the management gradually lost touch with the intimate details connected with the manufacturing processes. Thus arose a definite need for information with regard to the actual costs of the various products. This need can be fulfilled only through the medium of an efficient cost system. The manufacturer who fails to realise this truism undoubtedly not only obstructs his own progress, but is in effect a menace to the industry in which he is engaged.

The Elements of Selling Price.

The problem of works costing is, briefly to deal with the whole of the expenditure of a works, correctly allocate it to the various departments, and from thence to the individual products manufactured in those departments.

At the outset it is well to remember that the elements going to make up the selling price of product are as follow :—

1. Productive Material	Prime Cost of Article	Factory Cost of Article	Total Cost	Selling Price of Product.
2. Productive Labour				
3. Factory Expense				
4. Administrative Expense				
5. Selling Expenses				
6. Profit Factor				

In this article the author proposes to deal with the factory cost of product only, for once having ascertained this figure, the application of administrative, selling expenses, and profit factor presents few difficulties, and usually follows standard practice.

A modern system of accounts and costing will require information affecting profits and costs to be furnished monthly. For convenience and to save setting up unnecessary reserves, it will be found advantageous to take the "month" as consisting of four, four and five weekly periods in respect of each quarter. Hereafter the month is referred to as the "period."

TRADING AND DEPARTMENTAL TRADING ACCOUNTS.

In a large concern such as the author has in mind, the manufacture of the various products will naturally fall into separate manufacturing centres in the works, these usually being contained in separate shops or buildings. A further line of demarcation will be departments which are "Supply" or "Feeder" sections of the main departments; and the main departments for completed apparatus or product.

It may be well to point out that, in the trading account, the usual practice in this country is to deal with prime costs only (productive material and productive labour) against selling price, thus arriving at gross profit, and to charge factory expense, together with administrative and selling expenses, to profit and loss account, in order to arrive at the net profit. By this method it will be seen that the manufacturer does not obtain essential information as to his factory cost of product, whereas the trading and departmental trading accounts which the author has in mind deal not only with prime costs, but factory expenses, thus enabling the manufacturer to obtain a definite knowledge of his factory cost of product; the administrative and selling expenses being dealt with later in the profit and loss account in arriving at the net profits.

FACTORY EXPENSE.

The correct allocation of factory expense to departmental trading accounts is of vital importance, and requires careful treatment if one is to obtain correct departmental trading results and profits, and also at a later stage to obtain correct costs of individual products. It should be borne in mind that the figure of factory expense, as ascertained from a departmental trading account, has, in the costing stage, to be applied as part of the cost of the various lines of product manufactured in that department during the period.

Factory expense for the purpose of allocation to departmental trading accounts may be divided into two classes, namely:

1. Direct expenses, being those which can be allocated directly to departments, and comprise such items as non-productive wages of foremen, charge hands, storekeepers, shop clerks working in the department, &c., and

2. Indirect expenses, which are general to the works, such as rent, rates, taxes, depreciation, cost of time and wages office, works transport, research and works management.

The following examples will serve to illustrate the application of indirect expense to departmental trading accounts.

Rent: On basis of value of floor space occupied by each department.

Works Internal Transport: On basis of services rendered, a test being taken from time to time.

Depreciation of Buildings: On basis of the value of buildings in proportion to the area covered by the Department or Departments contained in the particular building or buildings.

Depreciation of Machinery: On basis of value of machinery contained in the Department.

Time and Wages Staff: On basis of the number of employees on Shop Pay Roll in the Department.

FINANCIAL ACCOUNTS AND COSTS.

In the author's opinion the cost system should, where practicable, form part of the financial system of accounts, and should be interlocked with same through the medium of departmental trading accounts, work in progress accounts, and cost accounts, thus ensuring accuracy of costing.

WORK IN PROGRESS ACCOUNTS.

Work in progress accounts will be kept for each Department. The departmental work in progress account will be charged with all productive labour and productive material expended, as also factory expense absorbed in the department during the period, and will be credited with the cost (as per Cost Accounts) of all apparatus or product dispatched from the department during the period, thus clearly showing the value of work in progress on hand in the department at the end of each period. For convenience of control, departmental stores are usually considered as forming part of the work in progress account of the department.

FUNCTIONS OF COSTING.

The functions of costing are to ascertain actual costs, and to collect within the cost system such information and statistics as may be necessary to assist the executive or management in directing their activities in accordance with the policy laid down by them.

The benefits and information which may be expected to arise out of an efficient cost system are as follow:

1. Comparison of past and present performance.

2. Comparison of costs obtainable for different periods under varying conditions.

3. To assist in supplying information with a view to standardising the work of the factory.

4. Comparison of cost with estimate, and also with a view to correcting future estimates.

5. Reliable costs of apparatus or product, which costs will be of assistance to the management when considering future policy.

6. The elimination of lines of manufacture carried on at a loss, and the consequent diversion of capital to lines of a paying nature.

7. To assist in obtaining greater efficiency.

8. To assist in the elimination of waste, whether from idle time, defective design, material or workmanship.

9. To assist in reducing the cost of production, by analysis of each composite part of the product, and the operations affecting same.

WAGES.

In organising a cost system the methods of making up, payment, and analysis of wages require careful consideration, labour being an important element in the cost. The booking of labour in the shops should be carried out so as to ensure correct booking of time, there being many well-known devices to cover this requirement. In this connection it will be found advantageous to publish in the shops standard lists of operations covering productive work, as also standard lists of occupations covering non-productive (or indirect) work, with instructions to workers as to the application of these lists. This practice will tend to ensure uniformity in recording the booking of productive and non-productive labour, which is essential to correct costs. The productive labour will be booked through the medium of the usual piece and day work ticket, or workers' production wages card; non-productive workers booking their time through the medium of a daily or weekly ticket or card. After the close of the working week, the time and wages office will work out and check all workers' piece and day work tickets, production wages cards, &c., at the same time balancing workers' time with the weekly clock card, and then proceed to make up the weekly pay roll. It is the practice in many works to have these pay rolls written up, either in book or loose-leaf form; the addition of such pay rolls being made by the human element, thus entailing waste of a considerable amount of time and money; whereas if modern practice be adopted, the whole of the operation of listing the necessary information on the pay roll, such as workers' numbers, hours, gross wages, insurance, deductions for club, clothing, &c., and net wages, can be carried out through the medium of office machinery designed for this purpose, the additions of the various columns being carried out by the machines at the same time. (*See* Table I.)

METHODS OF COSTING.

In an electrical manufacturing concern the method of costing varies in accordance with the particular apparatus or product under consideration. The method employed can be one of the following: (1) Single cost; (2) Job cost; (3) Job cost, sectionalised; (4) Job cost, by operation; (5) Job cost, sectionalised also by operation; (6) Unit cost, also by operation; (7) Combination of job and unit costing.

Single Cost. An example of this method may be found in foundry costing, providing the average cost per lb. or ton of the total output only is required; the single cost would be obtained by grouping the various charges in the departmental trading account under headings such as metal, productive wages, fuel. and other factory charges, and by dividing these charges either individually, by groups, or as a whole, by the total lbs. weight of foundry output. resulting in a single cost per lb. This single cost is frequently referred to as "a unit cost," such being incorrectly described. In practice, in the case of larger castings, it will generally be found necessary to keep individual job costs by operation.

Job Costing.—When job costing is carried out without reference to section. or operation, this undoubtedly is the simplest form of costing: the productive (or direct) wages and time occupied being booked to cost accounts through the medium of productive workers' piece or day work ticket, or wages production card: the value of productive material being booked to the cost account from stores requisitions or similar media. and the factory expense (or oncost) being applied to the cost account, relative to whatever basis may have been set up for the department. Information also as to total productive hours worked, productive wages, productive material, and factory expense, in connection with the job, will be forthcoming. The various methods of applying factory expense are dealt with later, under the heading of factory expense.

Job Costing by Section, or composite parts of the product.—An example of this method will be found in the costing of a turbine. Detailed information will be required of the cost of the various parts comprised in a section, and also of each section going to make up the completed turbine.

Job Cost by Operation.—In certain classes of manufacture information may be required not only of the cost of a job as a whole, or by section or part, but of the actual operations going to make up each part, section, or job. A simple example of this class of cost would be the cost by operation, of a casting

Table I.—PAY ROLL.

Department.................................. Dept. No.................. Week ending......................................19...... No............

Check No.	Hours.		Company's Insurance.		Gross Wages.	Overalls.	Club.	War Savings.	Paid in Advance.	Employees' Insurance.		Net Wages.	Check No.
	Regular.	Over-time.	Health.	Unem-ployment.						Health.	Unem-ployment.		
			d.	d.	£ s. d.			s. d.	£ s. d.	d.	d.	£ s. d.	
78000	413				0 17 1							0 17 1	78000
78001	422		3	1	1 2 2					4	1	1 1 9	78001
78002	47	33	3	2	4 10 5					4	3	4 9 10	78002
78003	462		3	2	4 0 8					4	3	4 0 1	78003
78004	47	2	3	2	4 0 1					4	3	3 19 6	78004
78005	451		3	2	3 18 4					4	3	3 17 9	78005
78006	402		3	2	3 10 3					4	3	3 9 8	78006
78007	45	131	3	2	6 11 7					4	3	6 11 0	78007
78008	47	40	3	2	4 14 0					4	3	4 13 5	78008
78009	461	162	3	2	6 8 10					4	3	6 8 3	78009
78010	47	130	3	2	6 2 4					4	3	6 1 9	78010
78011	47	100	3	2	4 3 4					4	3	4 2 9	78011
78012	17				1 10 4							1 10 4	78012
78013	45	2	3	2	4 8 7					4	3	4 8 0	78013
78014	47	2	3	2	4 2 8					4	3	4 2 1	78014
78015	461		3	2	4 0 3					4	3	3 19 8	78015
78016	442		3	2	2 4 1					4	3	2 3 6	78016
78017	30	130	3	2	4 12 10					4	3	4 12 3	78017
78018	462		3	2	4 0 3					4	3	3 19 8	78018
78019	17				1 9 6							1 9 6	78019
78020	43		3	1	1 0 10			2 0		4	1	0 18 5	78020
78021	47		3	2	4 2 3					4	3	4 1 8	78021
78022	47		3	2	3 4 8					4	3	3 4 1	78022
78023	462	62	3	2	4 15 0					4	3	4 14 5	78023
78024	421	10	3	2	4 8 2					4	3	4 7 7	78024
78025	163				1 9 0				1 9 0				78025
78026	46	62	3	2	3 10 9					4	3	3 10 2	78026
78027	47		3	2	3 3 7					4	3	3 3 0	78027
78029	47		3	2	3 3 7					4	3	3 3 0	78029
78030	47		3	2	3 3 7					4	3	3 3 0	78030
78032	36	42		2	3 5 9						3	3 5 6	78032
78033	453	161	6	2	5 4 4			2 6		8	3	5 0 11	78033
78034	47		3	2	3 4 8					4	3	3 4 1	78034
78035	47	100	3	2	4 3 4					4	3	4 2 9	78035
78036	43				0 16 3			1 0				0 15 3	78036
78037	47	22	3	2	3 12 7					4	3	3 12 6	78037
78038	47		3		3 5 10					4		3 5 6	78038
78039	47	22	3	2	3 11 5					4	3	3 10 10	78039
78040	47	162	3	2	4 13 0					4	3	4 12 5	78040
78041	45	81	3	2	4 7 4					4	3	4 6 9	78041
78042	462	82	3	2	5 0 5					4	3	4 19 10	78042
78043	47	123	3	2	5 18 5					4	3	5 17 10	78043
78044	382	62		2	3 6 11						3	3 6 8	78044
78045	47	112	3	2	4 13 6					4	3	4 12 11	78045
78046	45		3	2	4 11 1					4	3	4 10 6	78046
78047	453		3	2	3 9 7					4	3	3 9 0	78047
78048	45	81	3	2	5 11 11					4	3	5 11 4	78048
78049	421		3	1	0 18 8					4	1	0 18 3	78049
78050	47		3	2	3 14 3			2 6		4	3	3 11 2	78050
	2,121¼	197	129	83	181 18 3			8 0	1 9 0	172	123	178 16 8	

CASH ANALYSIS.

Sovereigns	£156 0 0
,, ...	11 10 0
Sixpences	0 12 0
Threepences	0 5 6
Copper	0 3 2
Silver	10 6 0
Total	£178 16 8

PAY ROLL SUMMARY.

Roll Made Up by	A. B.
,, Checked by	C. D.
Cash Analysis by	E. F.
Cash Given Out by	G. H.
Packets Made Up by... ...	I. J.
Packets Sealed by	K. L.
Number of Packets	M. N.

WAGES.

Paid Out by—
J. Hills,
In Presence of—
A. Straw,
Foreman.
Pay Roll Examined by—
J. Merry,
Supt.

PASSED FOR PAYMENT BY

T.O. Chief of Section,
D. George.
Works Cashier,
E. O. Johnson.

such as a yoke for a large machine. The operations would be costed and set out under the headings of coremaking, moulding, dressing, labour (if attached directly to the job), and tackle (if made specially for the job). Thus giving productive wages, productive material (if any), and factory expense, as also productive hours, for each operation.

Job Cost, Sectionalised, also by Operation, is a combination of methods Nos. 3 and 4.

Unit Costing. Where standard product or apparatus is made in large quantities, under conditions of mass production, such as standard meters, unit costing should be adopted, as by no other method will the necessary information be forthcoming.

Under mass production the management will not be interested in the cost of any particular customer's order, but in the cost of manufacture of a standard meter in the particular period under

Table II.—MOTOR DEPT.—COST RETURN. D.C. MACHINES.

Frame No. 16. Type M. Shunt Wound Motor, Protected. 26 H.P., 440 volts, 570 Revs. per Min.

STANDARD MECHANICAL PARTS—FIELD

Date *20th February*, 1920.

Part.	Ref. No.	No. Req.	Hours.	Feeder Depts. Labour.	Feeder Depts. F.E.	Motor Dept. Labour.	Motor Dept. F.E.	Material.	Total.
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Yoke	937	1	17½	...	...	1 10 7	1 7 9	20 4 6	23 2 10
Poles Main	373203	4	10	0 16 3	0 15 0	...	...	4 17 8	6 8 11
,, Comm.	360681	4	14	1 1 7	0 19 10	...	...	2 14 3	4 15 8
End Bracket F	725	1	20	...	...	1 15 0	1 11 8	6 10 4	9 17 0
,, ,, R	728	1	19½	...	...	1 14 1	1 10 10	6 12 7	9 17 6
Enclosing Cover	161962	2	2½	...	...	0 4 4	0 3 11	6 9 6	6 17 9
Pipe Connections... ...	...	...	...	...	...	...	...	...	...
Bearing F	4893	1	7	...	...	0 11 8	0 9 11	0 14 10	1 16 5
,, R...	940	1	6	...	...	0 10 0	0 8 6	0 12 6	1 11 0
,, Details	...	...	...	...	...	...	...	0 6 3	0 6 3
Eye Bolt	1"×1¾"	1	...	...	...	...	...	0 1 7	0 1 7
Total			96½	£1 17 10	£1 14 10	£6 5 8	£5 12 7	£49 4 0	£64 14 11
STANDARD MECHANICAL PARTS—ARMATURE CORE—									
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Punchings...	397009	220 lbs.	13	1 2 2	1 0 7	...	...	6 3 9	8 6 6
Vents & T.S.	401002	4	3	5 2	0 4 9	...	...	0 19 6	1 9 5
End Plates	7323	2	11¼	...	...	0 19 8	0 16 0	0 10 6	2 6 2
Core Assembly	373087	1	5½	...	...	0 8 1	0 7 10	0 6 3	1 2 2
Shaft & Keys	373322	1	10¾	...	...	0 18 9	0 17 1	3 2 10	4 18 8
Blower	374371	1	12	0 19 0	0 17 0	...	...	2 13 6	4 9 6
Total			55½	£2 6 4	£2 2 4	£2 6 6	£2 0 11	£13 16 4	£22 12 5
ELECTRICAL PARTS—FIELD—									
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coils Main...	29189	4	32	2 5 4	2 0 0	...	...	10 3 6	14 8 10
,, Comm.	29189	4	14	19 10	0 17 6	...	...	11 14 0	13 11 4
Connections	29189	...	2½	...	...	0 4 0	0 3 2	0 12 10	1 0 0
Brush Gear	327850	1	14	1 1 7	0 17 6	...	...	4 9 7	6 8 8
Terminal Board	397012	1	13	1 0 1	0 16 3	...	...	1 13 6	3 9 10
Field Assembly	397464	...	17	...	...	1 9 1	1 2 8	1 1 3	3 13 0
Total			92½	£5 6 10	£4 11 3	£1 13 1	£1 5 10	£29 14 8	£42 11 8
ELECTRICAL PARTS—ARMATURE—									
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coils	23617	41	27	1 18 3	1 13 9	...	...	10 19 6	14 11 6
Connections	23617	...	2	...	...	0 3 2	0 2 8	0 3 3.	0 9 1
Insulation...	23617	...	2	0 3 4	0 2 9	...	...	1 5 6	1 11 7
Winding	23617	...	46	...	...	3 11 3	3 1 4	...	6 12 7
Commutator	397826	...	14	1 2 2	0 18 8	...	...	14 17 2	16 18 0
Banding	397826	...	2	...	...	0 3 3	0 2 9	0 2 7	0 8 7
Total			93	£3 3 9	£2 15 2	£3 17 8	£3 6 9	£27 8 0	£40 11 4
ACCESSORIES.									
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Coupling	1161	1	9	...	...	0 15 9	0 14 3	0 15 9	2 5 9
Bedplate—S. Rails ...	510	1	8	...	...	0 14 0	0 12 8	2 12 6	3 19 2
Pillow Block	4242	1	13	...	...	1 2 9	1 0 7	2 1 9	4 5 1
Bearing	5118	1	15	...	...	1 5 0	1 1 3	1 4 0	3 10 3
Final Assembly	5118	...	78	...	...	6 13 3	5 10 6	...	12 3 9
Miscellaneous	...	...	6	...	...	0 9 6	0 8 6	3 16 9	4 14 9
Total			129	...	...	£11 0 3	£9 7 9	£10 10 9	£30 18 9
TOTAL			466½	£12 14 9	£11 3 7	£25 3 2	£21 13 10	£130 13 9	£201 9 1

Defective.		Development.		SUMMARY.			ADJUSTMENT.	
				—	Estimate.	Cost.	Dr.	Cr.
	£ s. d.		£ s. d.		£ s. d.	£ s. d.		
Design	0 14 6	Drawings ...	2 13 10	Labour ...	35 0 0	37 17 11	...	...
Work	1 2 3	Patterns ...	3 19 6	F.E.	30 0 0	32 17 5	...	...
Material	0 18 9	Tools ...	2 16 9	Material ...	127 0 0	130 13 9	...	...
				Development	8 0 0	9 10 1	...	...
Total ...	2 15 6	Total ...	£9 10 1	Total ...	£200 0 0	£210 19 2	£10 19 2	...

Total Prod. Hours 466½. The above figures are inaccurate, and are given only for the purpose of illustration.

review. Frequently one hears of an attempt to cost a product, made under conditions of mass production, on a job cost basis, with the result that information with regard to costs is not furnished monthly, but only at irregular periods, and even then without the necessary detailed information.

Taking the standard meter as an example, if job costing be applied it would mean that each batch order for meters placed in the shop would be costed as a whole, and the cost of manufacture could be given only as and when the batch order is completed, also bearing in mind that the manufacture of the various parts going to make up the complete order may have entailed months to manufacture. It will seldom happen that an order can be originated and completed in the same period. It will, therefore, be seen, before costs under this method can be presented in the period under review, that many parts will have been manufactured in the preceding periods, and consequently the costs will be out of date and useless for the purpose for which they are intended.

Given the same conditions of manufacture and applying unit costing, the necessary information as to cost of manufacture in the period under review will be forthcoming monthly.

Bearing in mind that all operations, parts, and assemblies are standard, all that is necessary to furnish unit costs is that each of the operations, parts, and assemblies shall have been carried out during the month under review, but not necessarily on the same order.

The method employed to ascertain the unit cost would be as follows: The manufacture of each individual part (with operations going to make up same) can be carried out on separate orders; these orders may be either for a definite quantity, in which case it should be arranged that not more than three weeks' supply be made on an order, so that completion of the order will fall in the current period, or on the other hand each individual part can be manufactured on a standing order, then the actual number of parts can be taken against the expenditure for productive material, productive wages, and factory expense incurred in making these parts, thus arriving at a unit cost for manufacturing each part in the period under review—the assembly being handled in the same manner. Having provided for ascertaining the cost for each part (by operation if necessary), as also unit cost of assembly, standard cost schedules would be drawn up. These would set out all the standard parts (by operation if necessary) under the various sections of the standard meter.

On the completion of the unit costing for the period, the cost of parts called for by the cost schedules would be drawn off from the various unit cost accounts to the cost schedule, at the price of the unit cost for each particular part, as also assembly. The addition of the standard cost schedules would then give the unit cost of manufacturing the standard meter in the particular period under review. It will, therefore, be seen that provided each operation is carried out, and each part made in the period, that the correct unit cost of making a complete standard article in the period can be ascertained.

An illustration of how unit costs, under mass production, are assembled, is given in the mechanical portions of the standard motor. (*See* Table II.) Where from the nature of the product the scrap in manufacture is heavy, the cost of scrap at each operation can also be included in the unit cost of each operation: this feature will be found in the manufacture of cartridges, the cost of scrap at each operation having an important bearing on the final unit cost.

Combination of Job and Unit Costing.—An example of this method of costing may be found in connection with switchgear and control apparatus. Many of the parts going to make up the whole may be standard to a number of classes of apparatus, and can therefore be put into manufacture in quantities. These parts are manufactured on what are usually termed side orders or standard part orders, and are costed on a unit cost basis, so as to obtain the cost per part. The assembly of apparatus will be costed (on job cost by section) under the main order numbers, and the special parts on sub-orders to the main order number.

When ascertaining the cost of the whole of the apparatus under the main or customer's order number, the cost of all special parts made on sub-orders to main orders will be transferred to the main order, and the standard parts required will be drawn from partly finished stores, and combined in the main cost under its respective part or section, at the unit cost price of such part. It will be seen that the cost by section, and as a whole, can now readily be arrived at.

A further example, and one where unit costing can be carried out to a greater extent, is in the manufacture of standard motors, certain lines of which may be manufactured in large quantities, and are standard, as far as the mechanical parts are concerned, whereas the electrical parts may vary with each customer's requirements, owing to voltage and variance in load.

Given these conditions of manufacture, the mechanical (or standard) portion of the motor would be costed on a unit cost basis, and the variable or electrical portion of the product on a job cost (by section) basis; an example of a motor costed on these lines is given. (*See* Table II.) It will be noted that the example sets out productive labour, productive material, and factory expense under each section, and also distinguishes between costs of feeder departments and costs incurred in the motor department; also the productive hours taken in manufacture. In addition the cost of any special development such as drawings, patterns, and tools are stated separately.

(*To be concluded*).

The Osram Lamp Factory.

A Unique Organisation for Mass Production.

Electric lamps have been produced in large quantities on mass production methods for the last 15 or 20 years, and therefore, the only novel application of the principle of which we hear so much to-day, is in improvements in machinery and methods of handling the component parts. As is well known, there are such a number of processes in lamp manufacture involving scientific, technical and manufacturing knowledge and experience, that only those manufacturers who have been engaged in the business the longest are i the position to increase output, reduce working costs and supply Apparently simple changes in the design of one part often involve radical changes in the machinery used in the manufacture of other parts, so that many factors have to be considered when a change is contemplated.

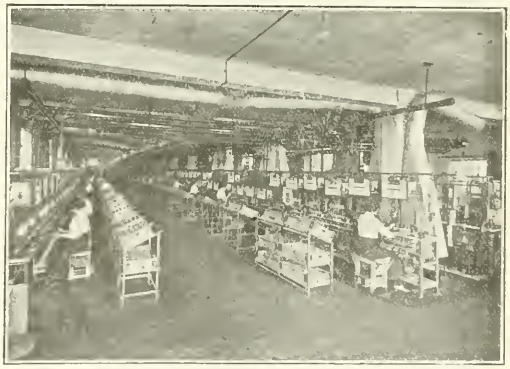


Fig. 1.—The Pump Room where Air is Exhausted from Osram Drawn Wire Lamps.

All operations and processes connected with the manufacture of Osram (G.E.C.) drawn wire lamps and Osram (Atmos type) lamps are carried out in the factory at Hammersmith, except that the necessary glass rods, tubes, and bulbs are received in bulk by rail from the G.E.C. Glass Works at Lemington-on-Tyne, and the brase shells of the lamp caps are pressed at the G.E.C. Art Metal Works in Birmingham.

The most important part of the Osram (G.E.C.) lamp is the drawn tungsten wire filament, which is produced from the crude ore

(Scheelite) and worked up even into the thinest filaments required for the smallest wattage high voltage lamps. The first operation in manufacturing a complete lamp is the foot making. The necessary glass tube, cut to proper length is flanged in a special automatic machine for the purpose, the glass rod and "studs" being made up on another machine. The "leading-in" wires are built up of copper, platinum and nickel, the flange then being assembled complete with stud and leading-in wires on a further machine to make a finished "seal." The filament supporting wires are next inserted and the necessary supporting hooks for the filament provided, this being wound on by a very simple process, and "set" by flashing in an atmosphere of hydrogen, diluted with nitrogen to prevent explosion.

IG. 2.—Fixing Stems for Exhausting Osram Drawn Wire Lamps.

The complete foot and filament are now inserted in the bulb, which has previously been provided with an "exhausting stem" and sealed in position. The bulb is now ready for exhausting; after this is complete the bulb is sealed off by which operation the "pip" is formed. This may be at the end of the bulb as is usually the case, or it may be concealed in the cap, the former being the most satisfactory from the "mass production" point of view. The exhausted bulb is now burnt on ageing racks to ensure that a perfect vacuum has been obtained. While burning the lamps are inspected and any faulty ones are removed and the faults rectified if possible, otherwise they are scrapped.

The next process is photometering (each lamp being tested and graded accordingly), after which it is capped, washed and polished, etched with the voltage, wattage and trademark, then finally tested, wrapped and packed ready for delivery.

As previously stated the caps are not received in their finished state from Birmingham, but require the insertion of the contact pieces and the fixing of these in position by means of an insulating material of a gloss like nature known as vitrite. This operation is carried out on a special automatic machine.

Atmos type, or gas filled, lamps are made similarly except that the following additional processes are necessary:—The filaments are all "spiralised," by winding the tungsten wire on suitable mandrills at high speed, great accuracy being necessary to ensure the correct spacing between the turns. After the bulb is exhausted it is filled with the necessary inert gas (argon or nitrogen, according to the type of lamp, nitrogen being used only for the heavy current lamps). The argon used for Atmos type lamps is obtained by direct fractionation of liquid air. Our illustrations show views in the works.

Mass Production as Applied to Machine Tools.

By E. W. Field.

The publicity which has been given to Mass Production by the non-technical papers during the past few months seems to be an attempt to belittle the efforts of many old-established firms, both now and hitherto. Mass production can be described as the intensive manufacture of a standardised article, and many firms have been doing this in a quiet way for years. It may be that the article they have made has been a small one for domestic use, and consequently it has not loomed up before engineers as an automobile would, but, nevertheless, mass production has been achieved. Specialisation is a good thing from most points of view, it reduces competition in many ways, and allows a better article to be produced, because greater attention can be given to the models in hand. As a natural sequence, the fewer the models made the greater the output of each of the remainder, always assuming that sufficient demand such production requires, is forthcoming. For instance, there is a much greater demand for a moderately-priced motor-car than there is for a machine tool of any type, and as a result production of the car is on a much more comprehensive scale than machine tool production can ever be.

It follows, therefore, that automobile factories are much larger than those devoted purely to machines. Where some of the largest firms have a production of 100,000 cars per year, a machine tool firm considers itself fortunate if 5,000 machines are produced in the same period. Most firms, if not all, engaged on machine tools, make at least half-a-dozen different models, and batches of 100 are considered large. This shows that mass production is open to interpretation in many ways, and to state that machine tools are manufactured on such a basis is somewhat misleading. Looking at the matter from a toolmaker's point of view only, there are several firms who can state, without fear of contradiction, that their products are the result of mass production, and it is one of these firms to which this article applies.

Capstan and Turret Lathes.

The scope of this article is intended to cover the production of capstan and turret lathes, and the practice of H. W. Ward & Company, Ltd., is drawn upon to provide the necessary material. Until 1912 the above firm made many types of machines, but at that date everything was dropped, except their present lines. Thus eight years of specialisation have tended to bring their present methods to that pitch when mass production is an effected condition, and not a misrepresentation of facts. Several models of lathes are built, and the methods adopted to satisfactorily handle the different items are developments resulting from years of experience. Many parts of these machines are common to several sizes, and are consequently built in much larger numbers than is any individual machine. Supply, always being governed by demand, is a peculiar master, and whilst one model is given preference at one time, efforts must be in another direction at a future date. The standardisation of as many parts as possible, is therefore, a great feature, and attention to this saves a tremendous amount of trouble.

The Programme of Work.

The system adopted is, generally speaking, as follows: The programme, having been decided upon, is issued to departmental heads three months before the actual machining operations are to commence. This period allows the buyer to formulate the quantities of material required, this being based upon material lists issued from the drawing office. His orders are sent out and material is to hand when the work arrives on the shop programme.

Periodically, governed by requirements, large batches of standardised parts are put in hand for stock, so that, when the machines are in the erection stages, these units are drawn from the finished part stores for assembly. Careful records of all items thus used are kept, and when the quantity in stock reaches a minimum figure new orders are issued.

It is obvious, to carry out this system successfully, that the units must be clearly defined and interchangeable.

The Place of the Drawing Office and the Inspection Department.

The drawing office governs the first requirement, and the inspection department the latter. Inspection is an important feature and limits must be rigidly adhered to. The firm mentioned in a foregoing paragraph has large inspection departments in which every part is inspected after each operation. Should faults occur they are either rectified or the part scrapped before further operations are effected. This type of inspection is costly, but on it depends the reputation of the firm. The progress systems are also very important, and in this connection the progress and inspection departments are closely allied.

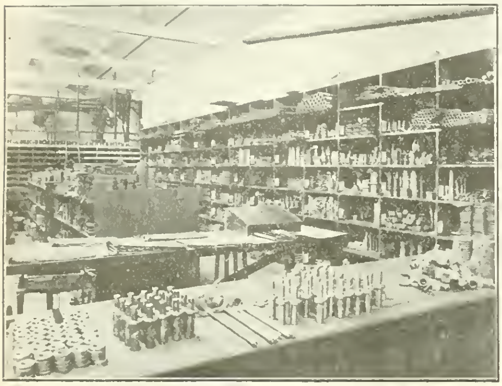


Fig. 1.—A View in the Tool Room.

Progress sheets of every part in hand are corrected every day, so that all parts can be traced and kept moving, with a minimum of lost time. Unit assembling is split up into smaller parts such as gear shafts, &c., and travelling inspectors watch these without cessation.

In addition to the actual machine, attention must be given to toolholders, and tools for the equipment, and similar methods are again used. Casual sale of such items forms a snag at times, so that every batch of tools put in hand has a percentage earmarked for the needs of machine orders. Tools in great demand are manufactured in batches of 250 or 500, the frequency of these lines being determined by the sales, records of which are taken periodically.

Turning to the actual works, we have one at Lionel-street, Birmingham, devoted entirely to small tools, repairs and experiments. The last two items do not interest us at present, so we will omit them. The machine shops at this works have an area of approximately 10,000 sq. ft., and the assembling shops 25,000 sq. ft. The plant is up-to-date, and is well supplied with capstan and turret lathes, each one being a standard machine made by the firm.

The Use of the Electric Vehicle.

Bournbrook Works was acquired in 1912, and contains a large machine shop, covering 25,000 sq. ft., and an assembling shop covering 35,000 sq. ft. The arrangement of the machine shop is based upon the idea of maximum accessibility to each machine, and, being on one floor, gangways are made for electric storage battery trucks to take and fetch all work to or from the stores and inspection department.

All heavy machines such as planers, radial drills, heavy boring machines, &c., are located in the erecting shop, so that all heavy castings are dealt with under the electric cranes running along each bay. There are four bays each one of which is devoted to certain sizes of machines. No. 1 bay deals with the assembly of units. Bay No. 2 with light and medium machines. Bay No. 3 with heavy machines, leaving Bay No. 4 as a painting and packing department.

At the end of the shop at right angles to the erecting bays is the final inspection department, served by all the cranes before mentioned. Each machine is first of all thoroughly tested for alignment by the charge hand fitter over the section, and also run under belt for a period to test all bearings. Arriving at the final inspection department it is again carefully examined and tried for its cutting capabilities. Records of all tests are kept giving full particulars of alignment, and also all equipment supplied with the lathe. Packing cases are standardised for each model, and are used over again immediately they are received back from customer. Great attention is paid to the packing, every care being taken to prevent damage to the machine whilst in transit.

Fig. 2.—The Assembly Benches.

Details of Shop Practice.

To return to shop practice, the question of efficient systems is one requiring careful study. By systems is meant methods of

Fig 3.—In the Machine Shop

procedure in different branches. For instance, the loan of standard gauges and tools to operators requiring them. A tool store is located in each of the main machine shops in which are kept several sets of external and internal gauges, micrometers, indicators, reamers, twist drills, taps and dies, &c. Each employee is supplied with a number of metal discs, each bearing his check number, and one of these must be handed in for each tool required. Should more than one man require the same tool he must either leave a check with the man from whom he takes the tool or get the checks changed at the stores returning whatever check he gets to its owner.

This arrangement is simple, and having stores in each shop prevents waste of time. These stores also keep special tools for the lathe, jigs and fixtures for milling and drilling, &c., but these cannot be withdrawn without a requisition signed by the section leader who is then responsible for the articles until they are returned. Located in the stores are cutter and tool grinders, and all milling cutters and drills are correctly ground upon their return from the shop. Large quantities of standard lathe and planer tools are kept, and these can be obtained upon receipt of a signed order from the shop foreman. In most cases the worn or broken tool must be returned for rectification at the same time.

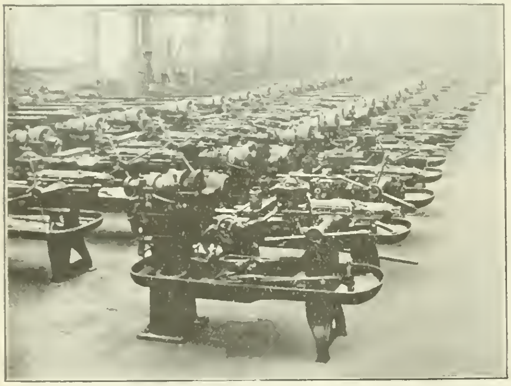


Fig. 4. A Group of Lathes.

As explained before, many of the parts of the lathes are standard to more than one size, and large quantities are therefore produced. The jig and tool department keeps careful check of all tools, and for the parts just mentioned a continual flow of replace tools is kept on hand in the tool-room. The cost department is an important department, especially in regard to special equipment of all types. Most of this is sold by estimate, and the records obtained therefrom are carefully tabulated for the benefit of the shop foreman, and the estimating department.

The Tool Room.

Special equipment cannot, of course, be made on manufacturing lines, and is, therefore, dealt with in the tool room. Drawings of everything thus made are carefully filed under cross-headings, and in most equipments each tool is numbered, so that it can be replaced at any time the customer requires it, on the number being mentioned.

All machines are built for stock, *i.e.*, all are finished off under numbers only, without anyone in the works knowing their destination. This is only possible on standardised lines built in quantity, but it avoids much unpleasantness on the part of customers who cannot say that another machine is being given preference. It is, of course, quite possible for the customer to see the actual machine he has purchased when it is in its erection stages, but this can only be done by reference to the works or commercial manager.

The Genesis of a Machine.

It is interesting to watch a certain batch of machines through the erecting stage, and probably the following word picture will be helpful. First we get a large bay, the floor being practically clear. Next, a number of apprentices, with the help of the crane, will erect the beds on the pans and legs. The next stage is hand-scraping the bearing surfaces to ensure accuracy. Apprentices do this under the supervision of a charge-hand. After this is finished, units are drawn from the finished part stores and are assembled in position. Gear boxes at the ends of the bed are bolted and doweled in position, headstocks are placed in position and secured and saddles are scraped to each bed. Cross slides are fitted to each saddle in the unit assembling department, and saddles are partially scraped, so that the actual assembly to the bed takes but a short time. Turret rests have all been assembled beforehand, and are finally placed in position. Each hexagon turret is bored in position on its own bed, from its fellow headstock, this being a most important operation as upon it depends, to a great extent, the accuracy of the machine. The hexagon turret is then dismantled, the tool bolt holes are drilled and tapped, and each turret face is hand scraped true with the bore, the parts being again assembled afterwards. Automatic chucks, if necessary, are next fitted, and each machine is then placed under belt for a lengthy run. During this period under belt, bearings are examined and eased, each machine finally passing into the inspection department. Here machines are again examined for finish and accuracy, and the final coat of paint applied. The machine is now numbered with its construction number, and is definitely allocated to the customer. This inspection department is connected with the despatch department, and is responsible for all extra equipment ordered with the lathe. Should a special tool equipment be on order with the machine, it is tested upon actual samples, which are submitted to customer to prove finish, limits and production time. The machine is not, however, finished with even after leaving the factory, as immediately its destination is reached and it is in position, a demonstrator follows up and instructs the operator in its use. After this a technical representative visits the machine periodically and reports progress to the makers. This is a good system, and often obviates trouble. Suggestions for alteration from actual users are carefully examined, and, if well founded, are incorporated in later models.

Thus a modern capstan lathe is a tool designed by engineers for engineers, and, without doubt, great possibilities exist in the future for this type of tool. The demand at the moment of writing is principally for lathes of 6½ in. centre, this being the most useful size of lathe to meet present requirements.

The Mass Production of Motor Cars.

When motor cars are mentioned in connection with mass production, our thoughts immediately turn to the Ford, but it is just as well to remember that mass production of cars is also being carried out by a number of firms in this country.

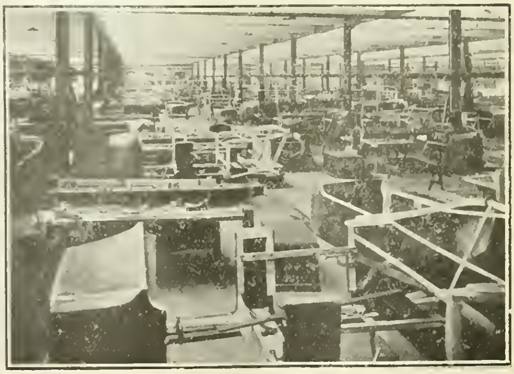


Fig. 1.—Coach Building Shop.

As an example, we give a description of the present position as regards mass production at the well-known Longbridge Works of the Austin Motor Company. These works were in being before the war, during which they were largely extended for the manufacture of munitions. Since the armistice the reorganisation of the factory for the large programme necessary to satisfy the world-wide demand for the firm's products has necessitated the erection of further buildings in order to house all the workers and machinery in the best possible sequence and order of arrangement for economic production. This reorganisation has also involved a radical alteration of the power plant for driving the works, and the installation and proper arrangement of a large number of automatic and semi-automatic machines in order that a definite plan of mass production may be carried out. This reorganisation is now completed, and the firm having turned once more to civilian pursuits is producing the well-known Austin Twenty car, as well as Austin lorries and tractors, and last, but not least, small stationary electric lighting sets, of which we recently gave a full description.*

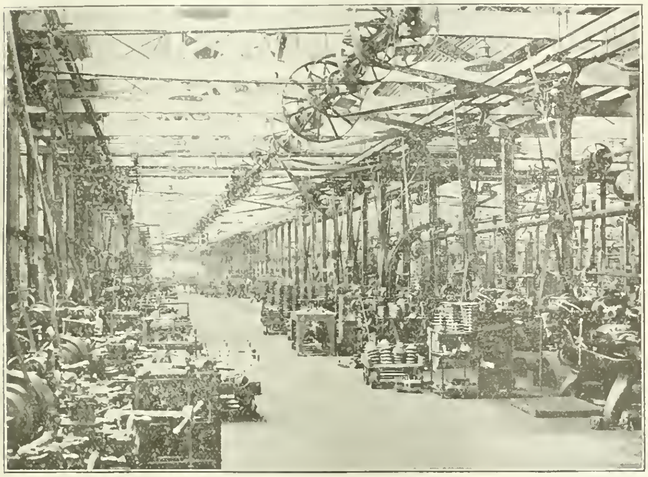


Fig. 2. One of the Machine Shops.

In any organisation for mass production it is necessary to get material to and from the works with as little handling and as great ease as possible. Ample sidings have, therefore, been provided alongside the three sections into which the works are divided. These sidings communicate directly with the Midland main line, with a branch of the Great Western Railway, and via Birmingham with the general railway system of the country.

To begin at the top, the general administrative control of the factory is centred at the South Works, where the designing, research, and other similar departments are housed. Here are also to be found the very complete welfare arrangements which consist not only of dining rooms, and the necessary accommodation in the way of kitchens, but also of excellently equipped reading rooms, library and large recreation rooms where the meetings of the Austin Technical Society and of the Social and Athletic clubs which flourish in connection with the works, hold their meetings.

The principal operations carried out in this section of the works are the machining the engine and transmission parts for cars, lorries and tractors. This is carried out according to the most modern methods in two shops, having an aggregate area of 170,235 sq. ft. This area includes the electrical department where the small stationary sets mentioned above are made, the sheet-metal shop, press shop, stamping shop, assembly shop, and the various test rooms, stores, packing, and other auxiliary departments.

The main power plant for supplying the works is situated between the north and south sections. It is equipped with twelve Lancashire boilers, which are fed by conveyers, and are fitted with automatic stokers. These boilers supply steam to three 1,500 kw. turbo-generators, whence energy is distributed by continuous current at 550 volts to the whole factory. The motors employed vary in size from ½ to 200 h.p., and they number 386.

The North Works are used for assembling tractors, lorries and car axles, and the machining of a large number of component parts of these vehicles. In these works the machine shop includes batteries of gear-cutting machines, lathes and drills, which form altogether an exceedingly fine assembly of useful and modern equipment for turning out machine parts in large quantities. They include Gleason bevel cutters, Fellows gear cutters, Gisholt lathes, and Jones & Lamson, Victor, Gould & Eberhardt and other machines, numbering in all some 600. In these works there is also included an exceedingly well-equipped steel foundry, with three stock converters and large pattern and machine moulding shops. Among the auxiliary buildings may be mentioned the oil stores, where 30,000 gallons of oil for the converters are stored. There are also wood and metal pattern storage sheds, hydraulic pump and accumulator and air compressor pump houses.

The West Works are used entirely for coach work construction, the main body erecting shop in which has an area of 211,889 sq. ft. Timber is brought to a special siding, adjacent to these works, whence it passes on trucks to the drying kilns. The breaking down mill is adjoining, and beyond is the saw mill equipped with Sagar & Robinson and other modern machines, and ventilated and cleaned by the Cyclone system.

Bodies and chassis are sprayed with paint by Airostyle and Lithos instruments in special bays, in which the air is changed 40 times an hour. The dry and dust-proof varnishing rooms are excellently aired, and fitted, and the finishing shop includes a trimming section. These works also include a large store for completed cars, a food store which supplies the whole works, and a mess room, additional to those mentioned above, which is capable of seating 2,400 persons.

In this article we have only been able to give in a very short and summarised way some idea of the lay-out of these modern works, and of the activities carried on by the firm. But we have doubtless said sufficient to show that some attempt at mass production of cars has not only been made, but has successfully been made in this country.

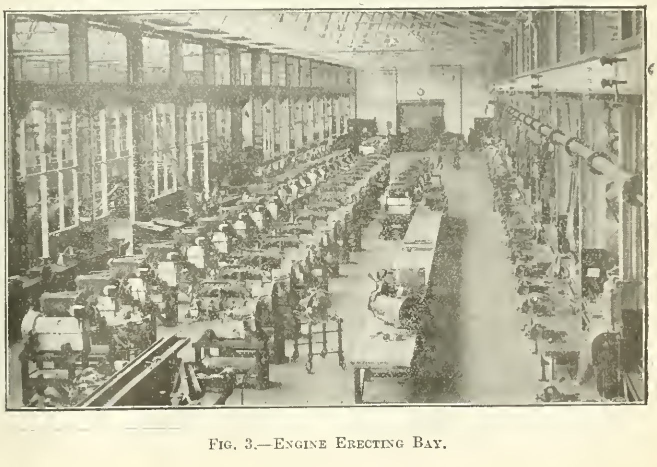


Fig. 3.—Engine Erecting Bay.

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* See The Electrician, Vol. LXXXIV., p. 291.

British Magneto Manufacture.

A large number of modern developments and the effect these will have on the progress of civilisation will depend on the design and manufacture of the magneto. No care is therefore too great to pay to the details of its improvement, and every effort should be made that the requirements of British industry are in this respect met by British industry. The manufacture of this class of goods in 1914 was practically in the hands of the foreigner, and without the war it is unlikely that we should ever have made up the leeway into which we had allowed ourselves to fall. It now remains to keep and to extend that market. We are not pessimistic about our ability to do this, and we are still less pessimistic after our visit to the Coventry works of the British Thomson-Houston Company.

The general design of the various magnetos turned out by the British Thomson-Houston Company has already been described in The Electrician. We may, therefore, in this article pay more particular attention to the methods by which the finished product is obtained.

At Coventry magnetos are being turned out in numbers which warrant the application of the term mass production to the operations there performed. By the end of the year the company hopes to achieve a weekly production of 1,500 magnetos of all types suitable for one, two, three, four and six cylinder engines. But in this connection it is desirable to sound a note of warning. A magneto is a delicate piece of apparatus, and much depends upon its performance. No desire for increased output must absolve its manufactures from the paramount necessity of testing each part, especially the electrical parts, at each stage to ensure that no weakness has crept in. This desideratum is ever present at Coventry. As an example, we may mention that a record is kept of the tests obtained on each armature, breakdowns are collated, and if it is found that a large number of breakdowns have occurred on armatures wound by one particular employee a close inquiry into the cause is made. It is sometimes found that these defects are due to carelessness, but as often as not they seem to be due to some subtle physiological cause which cannot yet be explained. In such case the employee is removed to other work.

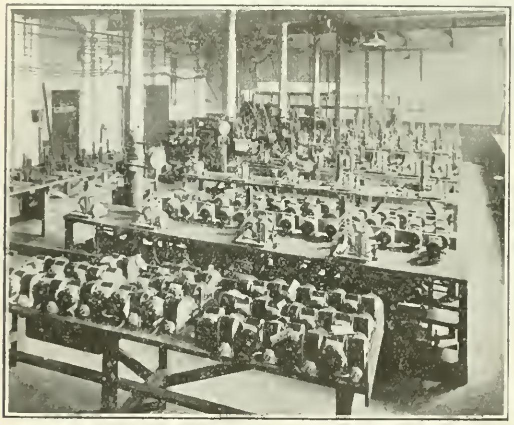

Fig. 1.—View of the Magneto Test Bench at the Coventry Works.

Turning to the process of manufacture itself it is, perhaps, hardly necessary to say that the most modern methods are used. Castings mouldings and other new materials come into stores through a loading dock on the ground floor of the works, and are then issued on trays for preliminary treatment at the machines. They stay on these trays throughout their journeys from the stores to assembly bench, and the lay-out is so designed that there is a minimum of unproductive movement. Great thought has been expended on the design of special tools and jigs for use on the various machines, and the methods employed are being constantly revised as experience dictates.

The most interesting part of the works is the winding shop. The H-shaped armature core after machining is first insulated with cambric and silk side pieces and wrappings, and is then wound with 200 turns of enamelled covered wire which form the primary. Another wrapping of insulation is then put on, and the armature then passes to the secondary winding bench. As the winding of the secondary is a more lengthy and more delicate operation than the winding the primary, more girls are employed on this work in order that the proper balance of progress may be obtained. The secondary winding consists of enamelled covered wire 0·0032 in. in diameter Each layer is insulated from the next by a wrapping of paper, and every third layer has a layer of silk flanged at the sides. As a preliminary one end of the primary is soldered to one end of the secondary and the necessary number of turns on each layer is put on automatically by an electrically-driven winder. This winder is so arranged that the turns put on each layer are uniform up to a certain point, beyond which they are less in a certain proportion than those on the layer before. This not only allows a better bedding to be obtained, but also reduces the stresses on the end windings. At the conclusion of the operation the wire is threaded to a loop of the same gauge wire, and the three fine wires taken three times round the core and soldered to a stout leading out wire which protrudes through the outer binding, being protected over its whole length by a fine varnished silk tube. The armature after the final binding and taping operations is first subjected to a vacuum treatment, and then varnished (whilst still hot) and subsequently baked for five hours at 200°F. This varnishing and baking is repeated three times, to ensure that the varnish coat is thoroughly hard and waterproof.

Fig. 2.—One End of Tool Room.

At each stage in the proceedings careful tests are employed, and selected machines are subjected to endurance tests of various kinds, with a view to discovering any weaknesses. The works are equipped with a very complete laboratory, where research work of a more elaborate kind and materials testing are carried out. Indeed, the one drawback to real mass production at Coventry is the difficulty of obtaining raw material.

The social side is not forgotten in the works organisation. A canteen is provided, and there are a number of clubs.

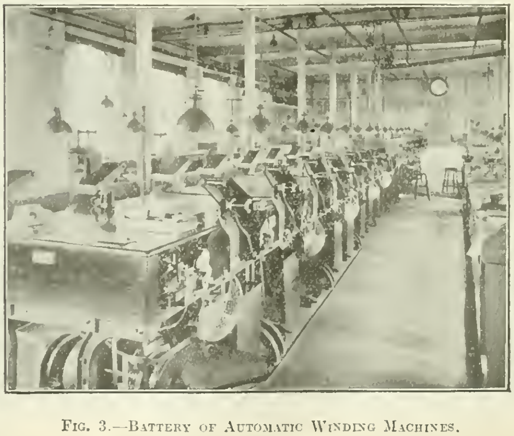

Fig. 3.—Battery of Automatic Winding Machines.

The Manufacture of Incandescent Electric Lamps.

Of all branches of the electrical industry the manufacture of lamps is the one that presents the best opportunities for the fullest application of mass production methods. The only feature in the demand that interferes with them is the large number of supply voltages for which lamps are required.

A most modern and up-to-date works is that of the Cosmos Lamp Works, Ltd., at Brimsdown, where drawn wire lamps in all sizes are made for many special purposes as well as for ordinary use. Every endeavour is made to obtain the greatest possible production of a high grade product, and with this end in view every detail of manufacture and lay-out is closely studied with a view to further improvement.

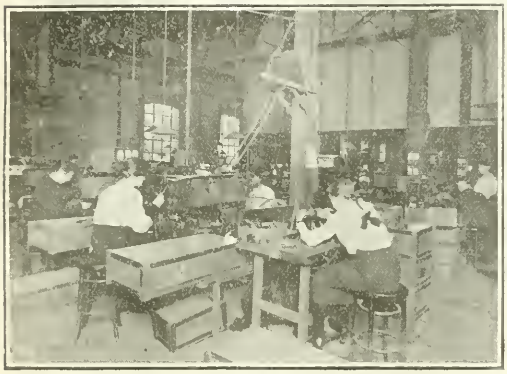

FIG. 1.—AN EARLY STAGE IN THE OPERATIONS.

The general arrangement of the works is such that the raw material enters the building at the point that it is required, whilst the manufactured details pass in one direction until they arrive at the packing department. In a works such as this where a large quantity of gas is consumed, the subject of ventilation is one that needs the closest study. The Cosmos works afford an example of the results that can be obtained, the ventilating system being so good that a visitor would hardly realise the need for one or that one exists. Another important question is that of lighting. The buildings are of the north-lighted storey type with a saw-tooth roof giving excellent daytime illumination. Much of the work, however, carried on in a lamp factory requires special local illumination, and artificial lighting must be used to supplement the natural lighting. By successive experiment a type of bench has been evolved, painted a light grey colour, and the lighting arrangements are so built into the bench that the light is thrown directly down on to the bench whilst the source is hidden from the direct vision of the worker.

The first item in the work of production is the cutting to length of the glass tube and rod used for the manufacture of the stem of the lamp and also of the tubing used for exhausting the globe. At one time the glass was cut by rotating it by hand against a diamond, but a revolving carborundum disc has now superseded the diamond.

Simultaneously the leading-in wires are made by joining together the three lengths of wire, copper, platinum and nickel respectively, in a gas flame. The tube that is to form the bottom of the stem has to be flanged so that it can be sealed into the lamp. The machine on which this is done has four positions. The first for placing the tube in the head, the second for pre-heating, the third for heating and forming, and the fourth for finishing and removal The object of pre-heating is to increase output and avoid cracking of the glass, and this principle is general throughout the operations.

The next operation is the assembly of the stem, flange and leading wires, which are set up in machines and welded together, to form the foot of the lamp. The foot then passes to an ingenious machine which inserts the molybdenum hooks that carry the filament. As the wires are led into position the stem is heated and a plunger descends on the end of the stem causing the plastic glass to form the button round the inserted wires, thus securely holding the ends. The wires are then cut out and the V hooks formed. This machine inserts the top and bottom hooks in two distinct operations, quite automatically.

Meanwhile the filament wire is being wound on a "former" in a zig-zag or figure-eight fashion. The wound wire is then heat-treated on the former in a neutral atmosphere so as to remove all grease and dirt and to get rid of as much of the occluded gases as possible before winding it on the lamp-stem.

At this point in the progress of manufacture the globes enter in trays, having been previously washed. These trays carry their consignment through the shop from one stage to another until final packing. The first operation, seen in Fig. 1, is to piece a length of tubing on to the globes for the subsequent evacuation process. The globes then go to the sealing-in machines, each of which is provided with five heads. In the first the wound stem is placed in position with the globe over it. In subsequent positions increasing heat is applied until in the final flame the neck of the bulb falls on to the flange, and they are then welded together. Excess glass is removed and the lamp is then ready for exhausting.

The exhausting is done on another automatic machine. In this case, however, the heads carrying the lamps are moved in an oven which takes the form of an incomplete ring. The gap in the ring is used for the final sealing off, which is automatic, and also for the insertion and removal of the lamp. Inside the oven the globe is first heated and then connected in turn to the low-vacuum system and then successive high vacuum pumps. Before emerging from the oven the bulb is flashed in view of the operator, so that the degree of vacuum may be judged. The operation of the doors to the oven is entirely automatic, opening and closing as the ring moves, being worked on the well-known "Geneva movement" principle.

The next operations are in the nature of finishing operations namely the cementing of the cap to the bulb and the soldering of the leading-in wires to the cap. The first of these is carried out in a ring type oven through which the lamp with the cemented cap in position passes, whilst the second is done by hand. The finished lamp now passes to the checking bench where the rating and voltage are checked. At this stage lamps are also picked out for testing purposes, both for life and candle power.

The use of one tray only for each batch of globes passing through the works enables a close watch to be kept not only on breakages but also on the behaviour of the raw material at various stages of manufacture. By checking the number of globes at each operation it is quite simple to trace at the same time any particular process that may be giving trouble. This method of watching progress is quite simple in operation in the works, whilst it enables all the necessary information for costing purposes to be quickly obtained, a feature that is not always provided for where mass production methods are being used.

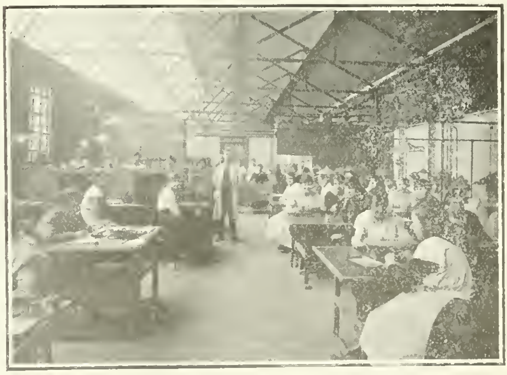

FIG. 2.—THE MANUFACTURE OF SMALL LAMPS.

The manufacture of the smaller miniature and railway and automobile lamps, Fig. 2, and also the half-watt type lamps, is carried on in the same way, although naturally the actual sequence of operation differs from that given. Every effort is made to ensure that the name Cosmos shall not be stamped on anything but a high-class product, and with this end in view the final inspection and testing is most rigorous. After final marking the lamp is again tested, and is then wrapped and packed ready for despatch.

Manufacture of Varnished Cotton and Silk Cloth for Insulation Purposes.

During the early days of the electrical industry ordinary paper and textile fabrics of various kinds were found useful for insulating the parts of electrical machines. Their value in this condition, however, was very small, and it was soon found that by treating the paper or cloth with varnish the dielectric strength could be considerably increased, and the practice arose of painting the paper or cloth with or dipping in varnish, followed by drying under ordinary atmospheric conditions. Subsequently drying in a heated air oven was employed. As the electrical industry developed, more exacting requirements and larger quantities of materials were desired, and considerable attention was given to the subject of improving technically these crude methods and materials and of cheapening production. In order to supply the demands of the electrical industry manufacturers soon realised that a continuous process of production, whereby long lengths of cloth or paper could be treated, was a necessity for economical production. In this manner the manufacture of varnished cloth originated in the United States as a speciality, and the material produced was sold under the name of Empire Cloth.

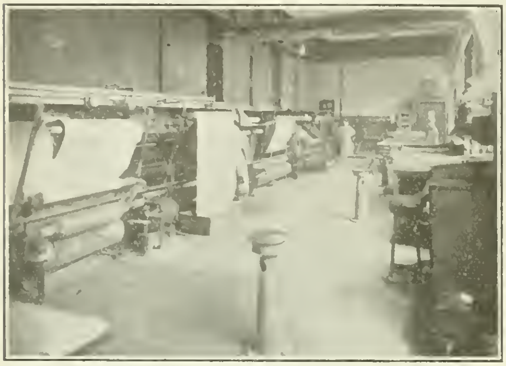
Fig. 1.—Interior of the Varnishing Room.

In recent years the manufacture of varnished cloth and tape for insulation purposes has been taken up in this country, among other firms, by the Ioco Rubber & Waterproofing Company, Ltd., of Glasgow. Appreciating the enormous development that is likely to take place in the electrical industry, this firm has devoted considerable amount of time and energy to the problem of producing insulating fabrics of superior quality on a large scale. The bulk of the insulating material produced is varnished cotton cloth, but occasionally, where very thin material is necessary, such as for magnetos, wireless apparatus and electrical instruments, varnished silk is used. The methods of treatment of the basic cloths are very similar except that the composition of the varnish and various technical details in the manufacture are adjusted to suit the different cases.

A large quantity of the varnished cotton cloth is used in the form of bias cut tape, which creates a difficulty not often realised either by the makers of varnished cloth or by the people who use it. As is well known, insulating tapes are subjected to a certain amount of tension when being wound in position, and when the tape is cut on the bias, owing to the fact that the threads in the cloth are not in line with the direction of pull, the tension falls upon the varnish film, and unless this film is tough and strong it becomes cracked and the insulation value falls enormously. In satisfying the requirements of the Metropolitan-Vickers Electrical Company, Ltd., and other electrical concerns, care is taken to ensure that any difficulties that arise in using these materials are immediately investigated, and steps taken to guard against any repetition, so that the Ioco Rubber & Waterproofing Company has always had a clear conception of the practical requirements in this class of material.

It has been found by repeated tests at the Metropolitan-Vickers Works that if bias-cut tape of an unsatisfactory nature is used the breakdown voltage in the case of a 7 mil tape may fall from 8,000 volts before stretching to 1,000 volts after stretching. This particular feature has been specially taken into account, and the materials and methods used by the Ioco Rubber & Waterproofing Company, Ltd., result in the film of varnish formed on the cloth being of such strength and toughness that it will withstand the tension required for winding without any great fall in its dielectric value. In the case of a 7 mil cloth a tension of 6 lb. per inch width can be applied, during which the breakdown voltage will not be less than 6,000 volts. All the material manufactured is submitted to this test, as well as the normal test of 8,000 volts. Great attention is paid to the details of manufacture in order to ensure that the thickness and quality of the material generally is regular. Realising that this is necessary for good performance of electrical machines, the makers have wisely insisted that every consignment is tested thoroughly; at the same time a close supervision is kept over all raw materials, and details of manufacture are controlled by textile and chemical experts, who are equipped with a very modern up-to-date laboratory, so that everything can be conducted on a scientific basis. Another point which is very closely watched by this firm is that particular attention is paid to the selection of the fabrics used and that the finishing process employed ensures uniform thickness and a smooth and even surface on the cloth, so that when the varnish is applied irregular thicknesses and rough surfaces are avoided.

The rolls of cloth as delivered by the cotton manufacturers are cut into lengths at an angle of 45 deg. These lengths are sewn together by a special sewing machine, which has been devised for the purpose, and are then rewound in rolls. Preparatory to varnishing the rolls are dressed with a filling material to bind the fibres and give a smooth finish after calendering. Experiments carried out by the Ioco Rubber & Waterproofing Company, Ltd., have shown that it is not desirable to "impregnate" the cloth in the way the term is usually understood, but that the best results can be obtained by applying the varnish in two layers, one on each side of the cloth. If a large quantity of varnish is absorbed by the cloth it cannot be successfully dried without subjecting the material to a high temperature which would damage the mechanical properties of the cotton.

After dressing, the cloth, which can be made either black or yellow, is passed slowly through a bath of varnish, and from thence up drying towers heated by steam pipes. The interior of the varnishing room showing the base of the towers is shown in Fig. 1. The temperature of these towers or tanks is kept constant within narrow limits, and the speed of the cloth adjusted so that when the material issues at the lower end the varnish is sufficiently dry to permit re-rolling. These rolls are then taken to a slitting machine, shown in Fig. 2, which separates the material into the required widths, and at the same time re-winds it in suitable cardboard coils. The ordinary cloth has a fairly dry surface, and is quite free from tackiness, so that no undue tension is required to wind this material when employed in tape form. When desired the cloth can be supplied with a thin coating of wax on the varnish surface. The manufacture of varnished silk is carried on in a similar fashion, but owing to the different nature of the material, straight cut tape will meet practically all requirements As with the cotton cloth, rigid batch testing is insisted upon. This testing is, in fact, regarded as a main sheet anchor of successful mass production of all insulating materials. The apparatus and technical staff required for this work is such that only in the case of firms manufacturing large quantities is the expense possible.

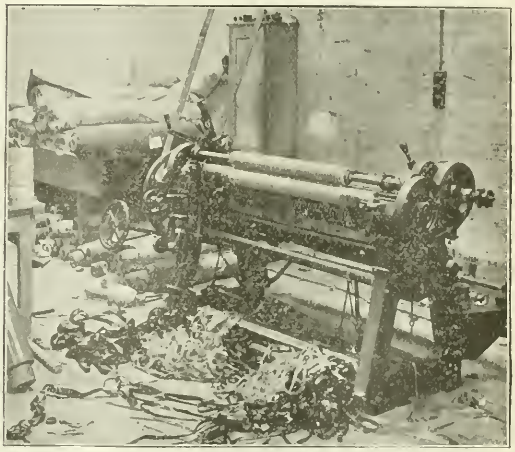
Fig. 2.—Manufacture of Varnished Cotton.

Mass Production of Cooking and Heating Apparatus.

For many years before the war articles of a somewhat timorous nature appeared, even in organs favourable to electrical development, discussing whether cooking or heating by electricity was a possibility. How much the situation has changed is clearly shown by the fact that mass production methods have been applied with great success at the Ileene Works and Moor-street Works (Birmingham), of the General Electric Company, Ltd., to the manufacture of electric cooking and heating devices of every description that to-day the weekly output approximates to the annual output of many firms who in pre-war days claimed a leading place in the industry.

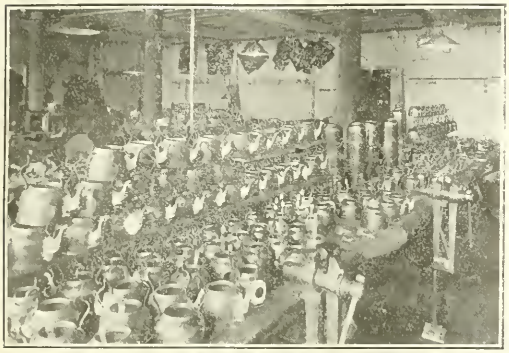

Fig. 1. A Group of Electric Kettles.

Ileene Works at the close of hostilities were in a favourable position for the adoption of mass production in the class of goods with which we are dealing. During the war, in common with the other works of the G.E.C., every possible step was taken to ensure a rapid output of war material by the installation of special automatic machinery. Immediately after the armistice the reorganisation schemes for peace found these machines adapted for the manufacture of the various parts of electric heating appliances.

The British public, as a general rule, does not require very ornate designs, and the G.E.C. wisely decided to concentrate on a few restrained, but none the less artistic, forms of radiator, while a similar principle has been applied to other devices, this being, as in all industries, the key to efficient mass production.

Another step in the same direction was the reduction of the numbers of standard types of element to three. One was for use in water-heating apparatus, hot plates, kettles, &c., a second in irons, and the third in radiators. This affords a very wide range of interchangeability. It is almost superfluous to add that plugs and sockets for all these various appliances are standard. As also few types of porcelain insulators are used, better deliveries are obtained from the suppliers than would be possible if they were not so standardised. The production of the elements is entirely carried out by automatic machinery, and very few seconds are necessary to convert a length of wire into the form suitable for attaching to the porcelain insulator.

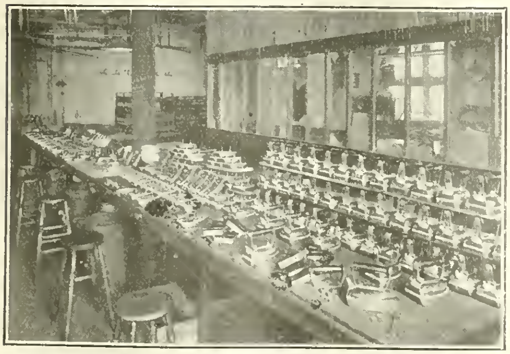

Fig. 2. Electric Irons in the Making.

Without entering into details it may be stated that very little manual work is needed before the assembly stage is reached. The output of the various machines is collected rapidly and methodically, and despatched to the appropriate assembly bench. Naturally, each series of benches is devoted entirely to work upon one standard article.

It is found that at the Ileene Works alone, in spite of their excellent facilities and their expert organisation, the augmented output required was unattainable. The Moor-street Works were therefore recently equipped for the manufacture of electric heating and cooking apparatus, and with this added source of supply, the machinery installed being of course on the same up-to-date lines as that of the Ileene Works, it may now be held that the output comes well within the designation of "mass-production." Rapid and methodical progression through the various shops, coupled with the use of high speed automatic machinery, has led within a comparatively brief time to the production of heating and cooking appliances on a scale which before the war was undreamt of, and which is likely to be greatly increased before many years have passed.

Benn Brothers Staff Dinner.

The staff of Messrs. Benn Brothers, Ltd., were entertained by the directors at a dinner at the Holborn Restaurant, London, on Friday last. Sir John Benn (the chairman of directors and founder of the firm) was in the chair, accompanied by Lady Benn; and all grades of employees, including the provincial representatives, were present, the company numbering about 190.

After the loyal toasts had been honoured on the call of the Chairman, Mr. Ernest Benn, C.B.E., submitted the toast of "The Staff." He reminded the company that that was the first anniversary of the establishment of Benn Brothers Prosperity Sharing Scheme. Since they last met at their staff dinner they had had to mourn the loss of Mr. Julius Benn, one of their founders. They had also to regret the absence of Mr. Haslam, through continued illness which had caused his retirement from the Board. It had been their pleasure and duty to add to the staff during the year some 10 or 12 ex-officers of H.M. Forces, and he offered a hearty welcome to those newcomers. The year through which they had passed had been one of the most remarkable for its hopes and its realisations in the history of the publishing profession. On the one hand, it was full of marvellous successes; on the other, it had brought difficulties in regard to printing and paper supplies that rendered the outlook most serious.

Mr. Benn referred to the satisfactory working of the Saturday closing arrangements and to the bonus sharing scheme. Last year they had paid to each member a sum equal to a dividend of 5 per cent. upon the annual value of their wages. A similar bonus was distributed among the staff at the end of the first six months of the current year. Owing to the difficulties arising out of the unprecedented situation in the paper trade, the prospect had become problematical, and it was impossible at the moment to make any definite statement as to whether the result of the year's working would enable them to make a second distribution in June. The success of Benn Brothers as a firm he attributed, among other causes, chiefly to the fine spirit of loyalty and co-operation which ran through the whole of the establishment and to the development of the system of individual responsibility.

Mr. E. E. Starke, in responding, after paying a tribute on behalf of the staff to the memory of Mr. Julius Benn, said that the directorate of Benn Brothers, which had preserved its character through so many years, and whose traditions were so intimately associated with our commercial life, was the personification of the qualities that had made the firm so great and powerful a name in the publishing profession. The excellent results of which Mr. Ernest Benn had spoken would not have been achieved had they not been influenced by men of brain, foresight and appreciation. On behalf of all, he could assure the directors that they would receive their hearty support and loyal co-operation in the future as in the past.

Sir John Benn, in briefly acknowledging the toast of "The Firm" (proposed by Mr. W. E. Warrilow), alluded to the inexorable onward march of Time. The 40 years since he founded "The Cabinet Maker," the first of the series of papers now owned by Benn Brothers, Ltd., had brought him many friendships and left fragrant memories of faithful service. Capt. Wedgwood Benn, M.P., who was also coupled with the toast, replied in felicitous terms.

Under the direction of Mr. J. P. H. Bewsher, a very pleasant programme of musical items was carried out.

The King of Spain visited Senatore Marconi's yacht "Elettra" at Seville on the 27th inst., when a Wireless Telephone Message was transmitted to his Majesty from the Marconi wireless telephone station at Chelmsford by Senor J. E. Roura, President of the Spanish Chamber of Commerce.

Correspondence.

CHELMSFORD STREET LIGHTING CONTRACT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: As the Press have drawn attention to the fact that Chelmsford has decided to revert to the use of gas for the street lighting of the Borough, I would ask you to publish this letter explaining our view of the case.

The streets of Chelmsford have been lighted by electricity for over 30 years. It has been stated that Chelmsford was the first town in the United Kingdom to use electricity exclusively for street lighting. My recollection of the matter is that Fareham was lighted in this way a few months before Chelmsford. There is no doubt, however, that Chelmsford was one of the pioneers, and it has always maintained its position in the electrical world. The old-established firm of Crompton & Company is still pre-eminent in the manufacture of electrical machinery, and in more recent years Marconi's Wireless Telegraphy Works have, by their establishment at Chelmsford, associated the town with another branch of the electrical industry. The contract under which we carried out the street lighting at Chelmsford came to an end on the 31st March last, and it was not renewed as our tender for a new contract was not accepted.

In 1911 the main street of the town was lighted by flame arc lamps, the other streets by means of 100 c.p. incandescent lamps, except for a few, which were lighted by gas.

Our tender, which was refused, provided that we should light the main street by means of ½-watt lamps, taking the same amount of energy as the pre-war arc lamps, and for this we tendered the pre-war price. For the other streets we tendered at an increase of 59 per cent., *i.e.*, £5 instead of 3 guineas per lamp per annum. These prices are, surely, a moderate increase in view of the changed circumstances in regard to the cost of material and labour. We have not been told why our tender was refused, but we understand that the gas lighting scheme shows a saving on the rates which we put forward.

The Chelmsford Gas Company was some years ago taken over by the Chelmsford Corporation, and the rate of 3s. 5d. per 1,000 cubic feet charged by the Gas Company in 1914 has now been increased to 5s. 7d., an increase of 64 per cent.

In the past we secured the street lighting in competition with gas; it would appear, therefore, that it is proposed to provide gas for street lighting purposes much below the present price to the general public: moreover it will, of course, be necessary to provide gas lighting equipment for all the streets and at present prices.

We can quite understand that having acquired the Gas Works the Corporation of Chelmsford are desirous of providing their own street lighting, but would like to take this opportunity of pointing out that their decision cannot have been influenced by any unreasonable demand on our part.—I am, &c.,

London, April 17. K. A. Scott Moncrieff,
Managing Director, Electric Supply Corporation.

"The Electrician" Electrical Trades Directory.

We much regret the delay that has occurred in the publication of the 1920 edition of "The Electrician Electrical Trades' Directory." As it should have been published by March 1, we have not been surprised to receive many inquiries asking the reason of its non-appearance. There are two chief reasons for the delay: The first is that, in order to increase the admitted utility of the volume, the publishers have taken the enterprising step of having the whole of the type re-set. This will greatly enhance the value of the directory. The second is due to the paper shortage, which is causing considerable difficulties throughout the whole of the publishing and printing trades. For instance, orders for paper placed as long ago as six months have only just been executed. Nevertheless, the whole of the 1920 edition of the Directory has now been printed and is in the binders' hands, and we hope, therefore, that the electrical industry will wait as patiently as it can for the short extra time before which it will be placed at their disposal. The demand for advance copies has been very large, and the price of the book will be 25s. net.

Institution of Mechanical Engineers Dinner.

The first anniversary dinner of the Institution of Mechanical Engineers held since the war took place at Connaught Rooms, Great Queen-street, London, W.C., on Thursday, April 22, the President, Capt. H. Riall Sankey, C.B., C.B.E., being in the chair. Those present included the Rt. Hon. Lord Birkenhead, Lord High Chancellor; Major Gen. Sir W. A. Liddell, K.C.M.G., Director of Fortifications and Works; Sir H. Acton Blake, K.C.M.G., Deputy Master of Trinity House; Sir Herbert Creedy, K.C.B., Secretary of the War Office; Sir J. J. Thomson, O.M., President of the Royal Society; Sir F. W. Dyson, F.R.S., Astronomer Royal; the Hon. Sir Charles A. Parsons, President of the British Association; Mr. Roger T. Smith, President of the Institution of Electrical Engineers; Eng. Vice-Admiral Sir George Goodwin, President of the Institute of Metals; Sir W. H. Bragg, K.B.E., President of the Physical Society; and Prof. Guillaume.

Mr. W. H. Patchell proposed the toast of "The Houses of Parliament."

The Lord High Chancellor, in reply, said that democracy with all its faults had not been conquered by despotism, and despotism would not be the government of the future. Democracy had been challenged by the admirers of the Russian system, who had declared that majority should not rule, that Parliament was obsolete, and would have to be superseded by committees of shops stewards and other well equipped statesmen. The tyranny of absolute monarchy would be preferable to the tyranny which was indicated by such a state of things. He believed the reason why the country had given the Government so much of its confidence in the last fortnight was not that it was satisfied with all the Government had done, but that it knew that the Government had never faltered on the fundamental issue of imposing our will on our enemies, and that since the war it had never ceased to do everything in its power to win for this country the great fruits of its sacrifices.

The President in proposing the toast of "His Majesty's Forces" said that during the war 1,314 of the members of the Institution had served in the forces and many more had had to remain at their posts to win the war by engineering work. While in the past the forces of the Crown had been a close corporation the war had turned the nation into His Majesty's Forces.

Major-General Sir W. A. Liddell, in reply, agreed that the last war had been an engineer's war, but the next war, if ever there was one, would be a mechanical engineer's war, because the use of mechanical and electrical power must go on increasing.

The toast of "Kindred Societies" was proposed by Sir John Dewrance, who called attention to the very useful work that was being done by scientific and technical societies in combination in carrying out work of the British Standards Association and the National Physical Laboratory. The latter had, during the war, been an asset whose value could hardly be over-rated. The education and status of candidates for admission to scientific and technical societies could not be dissociated from the question of education generally. The membership of such societies should not be regarded as a substitute for university degree.

Sir J. J. Thomson, in reply, said that the methods and difficulties of pure and applied science were to a large extent the same. Indeed, the difficulties of the latter might be greater, for the former had only to deal with the forces of nature while the latter had to deal with the forces of human nature. He thought that in unexpectedness the human being transcended all the apparatus which now crowded our laboratories. The engineer had also to deal with the questions of finance from which questions the pure scientist was free as he had no finance! The war had done a great deal for science and had taught scientists the great difference between inventing a thing and bringing it to a stage when it could be submitted to the rough usage of everyday life. The war had also shown it was probable that there was no scientific knowledge which could not be adapted to the service of man. The development of the thermionic valve was a case in point.

Sir John Griffiths in proposing the toast of the "Institution of Mechanical Engineers" said that there had been differences between various learned societies during the past year on the subject of registration, but with good temper on all sides a satisfactory conclusion should be reached. It was the Institution of Civil Engineers' desire to register engineers who were not members of the Institution of Civil Engineers. This gave rise to difficulties of definition, but sooner or later agreement must be reached as to what constituted a civil engineer, what his general education, his technical education and his professional education and professional experience should be.

The President, in reply, said that he was glad Sir John Griffiths had removed the misconception which was in many minds on this question of registration. The Bill had originally been somewhat circumscribed, and the Institution of Mechanical Engineers could not, therefore, see their way to agree to all that was proposed. Engineers desired registration in order to improve their status. He suggested a conference of the leading institutions which should be unofficial at first to determine procedure. He hoped that this arrangement would lead to the establishment of an Engineering Senate and a conjoint board for examinations, the expenses of which were now prohibitive.

Electricity Supply.

Worcester Corporation has applied for sanction to borrow £15,000 for additional cables, sub-station equipment, &c.

We regret that the promoters of the Dartmoor Hydro-electric Scheme have been compelled, owing to the opposition to the Bill, not to proceed further with the measure this year.

The Ammanford Urban Council has agreed to purchase the local electricity works from Mr. Herbert. The purchase price will amount to about £15,000.

Stepney (London) Council is recommended by the Finance Committee to increase the salary of the borough electrical engineer, Mr. W. C. P. Tapper, from £1,150 to £1,700.

There are at present 5,070 consumers of the Hammersmith (London) electricity department. Tenders are to be invited for two 8,000 to 10,000 kw. turbo-generating sets. As there were so few tenders for the supply of annual stores, no tenders were accepted; but orders will be given out as required. The Electricity Committee having considered the tenders for the supply of e.h.t. and l.t. cables, transformers, switchgear, &c., recommend the acceptance of offers for certain of the items.

Brighton Corporation has decided to apply for powers to supply electricity in the Portslade district. Already supply is given to certain big businesses in the area and arrangements have been made with Portslade Urban Council to supply the whole of the area. The prices for current will be 12½ per cent. above those charged to Brighton consumers. Certain of the existing mains can be utilised and the engineer (Mr. J. Christie) is confident that the revenue already assured will justify the Corporation in embarking on the scheme.

The Electricity Commissioners have intimated to Warrington Council that a new generating station in the town is not in accordance with their ideas, but the installation of an additional generating set at the existing station would receive favourable consideration. The Council has therefore decided to apply for sanction to borrow £183,433 for extending the existing plant, and the proposal to obtain a temporary supply of current from the Widnes power station of the United Alkali Company has been abandoned. The charge for current for lighting has been increased by 10 per cent. and for power and heating by 20 per cent.

Brighton Corporation has adopted the scheme prepared by Mr. Christie for the supply of electricity to the municipal houses at Moulsecombe. The consumer must enter into an agreement with the Corporation to take a fixed maximum demand each quarter, at the rate of 1s. a week in the summer six months, and 2s. a week in the winter six months, per 100 watts of demand. Controls will be fitted, so that if the consumer is taking too much electricity at any time, the lights will flicker or go dim until the extra lights have been switched off and the load reduced to the agreed amount. Various adjustments will be made to ensure that the cost comes to about the same as that charged to other consumers. Application is to be made for sanction to borrow £5,000 for 20 years for the cable service and street works, and £2,500 for controlling devices. The tenants will be required to use electric light exclusively.

Among the new housing schemes for which electric lighting is to be adopted are those of Kilmarnock and Aberdeen Corporations. Tenders are being invited by the former and at Aberdeen the Electricity Committee is consulting with other committees as to the supply of electricity for the new houses to be built in Torry. At Sheffield the chairman of the Estates Committee reports that the cost of wiring and installing the fittings in the Corporation houses on the Walkley Hall Estate will be £10 per house, the total cost being £1,840. Arbroath Council has been informed by the Ministry of Health that it has no objection to the proposal to install electric light in the new houses, subject to satisfactory tenders being received.

Electric Traction.

Wigan Council have applied for sanction to borrow £26,000 for the purchase of 12 new double-deck, broad gauge tramcars.

The Gateshead & District Tramways Company has decided to discard the use of centre tramway standards, and side poles with span wires are to be substituted. The track is to be doubled in busy centres, and it is expected that in the near future the Gateshead lines will be linked up with Newcastle and the Northumberland coast.

The Keighley trackless trolly system is in a bad condition and great difficulty is being experienced in effecting repairs. The cars being of Austrian make, it is impossible to secure extra parts, and carry out repairs. The Chairman of the Tramways Committee said that to convert the motors from the Austrian to a British type would be very expensive. It was hoped to have an improved service in the very near future.

The London County Council is extremely unfortunate in its legislative proposals for the extension and improvement of its tramway system. The Borough Councils possess the right of veto on extensions, and several of them objected to the proposals in this year's L.C.C. Bill, which were of a comprehensive character. As the Standing Orders had not been complied with, a proposal was made in the House of Commons last week to dispense with their compliance. The motion was, however, rejected, and further delay will occur before the L.C.C. can get the powers it requires to put its tramways on a proper basis to meet existing requirements. Though some of the proposed extensions were very undesirable, others would be useful connecting links, and it is a pity that the good should have been rejected with the bad. In our opinion, it would have been much better if the Bill had been allowed to proceed, so that a Committee could consider its merits.

Foreign Notes.

It is announced that a group of Spanish capitalists have acquired the Santiago (Chili) & Buenos Aires electric supply and tramway undertakings of the Deutsche Uberseeische Elektricitats Gesellschaft.

An issue of 5½ per cent. railway bonds was recently made by the Swiss Federal Railways, for the purpose of obtaining the funds necessary for the electrification of the Federal Railways.

The Allgemeine Elektricitats Gesellschaft, of Berlin, which proposes to absorb the Felten & Guilleaume Carlswerk A.G., has decided to increase its share capital from 200 to 300 million marks. When the amalgamation has taken place, the A.E.G. will be the largest German industrial unit. Some time ago the A.E.G. acquired the lamp works of the Auer Company and formed a trust for the electric lamp industry.

Catalogues, Price Lists, &c.

List No. 302 of the Sun Electrical Company, Ltd., gives particulars and prices of all lamps at present available. Copies may be had from 57/9, Neal-street, Long-acre, W.C.2.

A striking poster, well printed in colours, has been issued by the British Electric Development Association, which brings out clearly the economic and other advantages of electric cooking. Copies may be obtained from the director and secretary, Mr. J. W. Beauchamp, Hampden House, 84, Kingsway, London, W.C.2.

The Chloride Electrical Storage Company has issued a neat folder dealing in a concise manner with "Nine points of special excellence about the Exide Battery" for starting, lighting and ignition purposes. Copies of the folder may be obtained from Clifton Junction, Manchester, or the company's London showrooms, 320, Shaftesbury-avenue, W.C.2.

Messrs. Siemens Bros. & Company, Ltd., Palace-place-mansions, W.8, have issued a pamphlet which contains a description of their Electric Helm Indicator, with diagrams of connections. The apparatus has been designed to indicate the angle of a ship's rudder or helm in a reliable manner on the navigation bridge; or, if desired, in any other position. It is operated by a separate battery of one dry cell, being thus independent of the ordinary electric supply of the ship. The angle of the rudder is indicated positively each 5 deg. without any backlash, so that the usual trouble experienced with gear operated by chains and wire ropes is absent. The gear is simple and strong, consisting of a switch, an indicator and a battery.

Business Items, &c.

The telephone number of the Sloan Electrical Company, Ltd., is Clerkenwell 2032 (four lines).

Messrs. Connolly's (Blackley), Ltd., have opened offices and stores at Bradfield House, 27, Hunslet-road, Leeds, where stocks will be kept of all their manufactures, such as insulated wires and cables, cotton and silk covered wires, &c.

The partnership between Thos. A. Tooley, Hy. A. Burrows and Noah Emberton (trading as Tooley, Emberton & Burrows), electrical engineers, &c., 5, Lytton-grove, Seaforth, Lancs., has been dissolved. Debts by Messrs. Tooley and Burrows.

Capt. J. Huntington has been appointed district manager for Bristol and the S.W. of England by Messrs. Simplex Conduits, Ltd. Capt. Huntington joined the firm 18 years ago, and has held many positions on both the sales and works side of the business. He served during the war, was mentioned in despatches, and gazetted captain. He rejoined his old firm in 1919.

Personal and Appointments.

Dr. J. H. Andrew has been appointed professor of metallurgy at the Royal Technical College, Glasgow.

Mr. J. P. Kelly, B.Sc., has been appointed lecturer in electrical engineering at the Heriot Watt Technical College, Edinburgh.

Prof. H. J. W. Hetherington, of Cardiff, has been appointed Principal of Exeter University College in succession to Principal Clayden, who has recently resigned.

Mr. J. H. Bolam, M.Sc., M.I.E.E., has resigned his position as Borough Electrical Engineer at Weymouth and he will sail for India on the 22nd prox. in order to take up an appointment with an engineering firm interested in power supply.

Rochdale Corporation is recommended to increase the salary of Mr. F. H. Rudd, borough electrical engineer, from £500 to £700, with a further increment of £50 next year and £50 in 1922. The Tramways Committee also recommend that the salary of the general manager (Mr. George Webster) be increased from £600 to £800 per annum.

The Board of Trade have appointed Mr. T. Turner to be secretary to the Water Power Resources Committee, in place of Mr. R. T. G. French, and communications should be addressed to Mr. Turner at the Board of Trade offices, Great George-street, S.W.1. Mr. French will, however, continue to assist in the work of the Committee so far as his new duties as secretary to the Electricity Commissioners will permit.

Liquidation.

The Alliance Electrical Company, Ltd., is being wound up voluntarily for the purpose of liquidation, and Miss E. McArthur has been appointed liquidator, with authority to consent to the registration of a new company under the name of the Alliance Electrical Company, Ltd., and to enter into an agreement with such company.

Miscellaneous.

Cable steamers started on Monday to lay a NEW SUBMARINE TELEGRAPH CABLE across the Channel from Dover to Ostend.

We regret to announce the death of Mr. Marlborough R. Pryor, director of the Central Electric Supply and the St. James's & Pall Mall Electric Light Companies.

Strong opposition is being organised against the proposed INCREASE OF THE Excess Profits Duty, and the Association of British Chambers of Commerce has requested the Chancellor to receive a deputation on the subject. The Federation of British Industries will make a similar protest, and a conference of manufacturers, called by the National Union of Manufacturers, will be held at the Guildhall, London, E.C., on May 7, in order to consider the position.

We are not surprised to learn that the Federation of British Industries have protested to the Board of Trade against the methods of the Central Profiteering Committee in publishing the recent Report on the Electric Lamp Industry. It is alleged that the Committee published confidential matter as to labour costs, material, &c., in contravention of clause 5 of the Profiteering Act, and this publication is considered to be most detrimental to the interests of British industry. The Federation think that profiteering committees should have higher technical qualifications for their task than they possess at present, and a committee has been appointed to make representations on the subject.

In reply to a question in the House of Commons on Monday, Sir R. Horne said that the representations made by the Electric Lamp Manufacturers' Association concerning the report on the electric lamp industry had been referred to the Sub-committee in order that they might consider whether they desire to modify their report in any respect in consequence of the representations. The Sub-committee's reply was only received on Saturday afternoon, and until he had had an opportunity of considering it he was unable to make a definite statement on the matter.

The annual general meeting of the Electrical Trades Benevolent Institution was held on Monday under the presidency of Mr. J. Y. Fletcher.

The Chairman, in moving the adoption of the Committee's report and the accounts, stated that the income for 1919 was £3,502, compared with £1,188 in 1919. This satisfactory increase was due to Mr. Hunter's appeal, which was sent out at the end of 1918, and the appeal by Mr. Cash at the annual festival, which was held for the first time since the war. Members' subscriptions showed a total of £259 (against £121). The number of members had increased from 115 to 181, and the number of life members was now 81 (against 61), with an increase in contributions from that source of £391. Dividends received were £524 (against £432). The cost of working the Institution increased from £186 to £258, the increase being largely due to the cost of sending out the appeals in connection with the festival and to increased cost of postage and stationery. The number of applications for assistance in the past year, although they resulted in twice as many grants being made as were made in the previous year, were still almost negligible, a fact which was entirely due to the condition of the labour market. Assistance was given to every qualified person who applied, but it might be viewed as a matter of certainty that the time was not far distant when the condition of the labour market would be much changed, when undoubtedly there would be heavy calls on the resources of the Institution. The amount carried forward to capital account was £3,143 (compared with £962); of this sum, £1,733 had been invested in 5 per cent. War Bonds and a 4 per cent. funding loan, and during the year a further £1,742 had been invested in 5 per cent. War Bonds. The total of investments was £12,539.

Mr. H. Bevis seconded the motion for the adoption of the report and accounts, and it was carried unanimously. On the motion of Mr. R. W. Hughman, Messrs. W. B. Esson, E. Garcke, T. E. Gatehouse, C. E. Hunter, Sir Ernest Spencer and Mr. Geo. Sutton were re-elected as members of the Committee. Mr. Bevis proposed the election of the chairman (Mr. Fletcher) as a member of the Committee, and Mr. F. B. O. Hawes (secretary), on behalf of the Glasgow Local Committee, proposed the election of Mr. R. B. Mitchell, city electrical engineer of Glasgow. Both proposals were adopted.

The Chairman proposed that rule 17 be amended by substituting £12 for £6 in the fifth line, and £100 for £50 in the tenth line. This would enable the Committee to make grants to the children of deceased members at higher rates than were now permitted. The motion was seconded by Mr. J. E. Edgecombe and carried unanimously, and a special meeting will be convened to confirm it.

Institution Notes.

A special general meeting of the Rontgen Society will be held on May 4 to consider certain alterations of the rules, including the increase of the annual subscription from one to two guineas. The annual general meeting will be held on June 1.

The ex-members of the London Electrical Engineers are holding a re-union Smoking Concert at Cannon-street Hotel on June 2 at 7 p.m. Tickets (price 2s. 6d.) may be obtained from the hon. secretary of the Concert Committee (Sergt. F. Frakling), 108, Heathwood-gardens, Charlton, S.E.7. It is hoped to inaugurate an Old Comrades' Association.

The annual dinner of the Faraday House Old Students' Association will be held at the Holborn Restaurant, London, W.C. 1, on Tuesday, May 4, at 6.30 for 7 p.m. Mr. G. Scott Ram, M.I.E.E., H.M. Electrical Inspector of Factories, the President, will be in the Chair, and the dinner will be followed by an excellent musical programme. Old students desirous of attending should communicate at once with the Hon. Secretary.

Tenders Invited and Accepted.

Lochgelly Corporation want tenders by May 5 for the electric wiring of 74 new houses. Specifications from the Burgh Surveyor.

Dundee Corporation require tenders by May 10 for 1,055 tons of steel tram rails, manganese steel points and crossings, &c. Specifications from the City Engineer.

Lincoln Corporation want tenders by May 24 for coal-handling plant. Specifications from Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, London, S.W.1.

Nuneaton Corporation require tenders by May 5 for supply of three-core and four-core l.t. paper-insulated cables. Specifications from the Borough Electrical Engineer.

Sheffield Health Committee invite tenders for 10 electric tipping wagons for house refuse collection. Tenders (with complete specifications) to be sent to the superintendent, Mr. J. A. Priestley, by May 10.

Falkirk Parish Council require tenders by May 8 for about six months' supply of electric lamps, &c. Forms of tender from Mr. John Macpherson, Poorhouse, Falkirk.

Dublin Electricity Supply Committee require tenders by noon May 3 for a 7½ H.P. three-phase motor. Specification from the Committee, Lord Edward-street, Dublin.

Bo'ness Corporation require tenders for electric wiring in a first instalment of 12 houses of their Marchlands-road housing scheme. Schedules from Mr. John Louden, Director of Housing, Burgh Chambers, Bo'ness.

Dingwall Corporation require tenders by May 7 for electric wiring work in connection with the erection of 35 houses. Specifications from the Architects, Messrs. Mackenzie & Macdonald, or Mr. D. Matheson, Dingwall.

Manchester Electricity Committee require tenders by June 7 for supply and erection at Barton power station of 33,000 volt and 6,000 volt main switchgear, pressure testing switchgear, &c. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

The Tuberculosis Committee of Management of Dublin Corporation require tenders for the renewal and maintenance of a storage battery (630 ampere-hour capacity at 10-hour rate of discharge) at Crooksling Sanatorium, Brittas, co. Dublin. Particulars from the City Engineer.

Mossel Bay (Cape Province) municipality require tenders for supply of steam engines, boilers, air and circulating pumps, condensers, piping, &c., alternators, switchboard, poles, street lamps, meters, cables, &c. Particulars can be obtained from the Department of Overseas Trade (Room 48), 35, Old Queen-street, London, S.W.1.

The Agent-General for Western Australia invites tenders for one 7,500 kw. turbo-alternator and condensing plant for the Perth power station. Specifications from Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1, and tenders to the Agent-General, Savoy House, Strand, London, W.C.2, by noon May 14.

The Agent-General for Victoria invites tenders for four 4,500 kw. and eight 1,000 kw. 1,500 volts converter traction sets for the Melbourne and suburban electric railways. Specifications, &c., from the Agent-General, Melbourne-place, Strand, London, W.C.2; and further information may be obtained from the consulting engineers (Messrs. Merz & McLellan), 32, Victoria-street, London, S.W.1. Tenders by noon May 31.

Middelburg (Transvaal) municipality require tenders by noon May 29 for the supply of plant, including two boilers with superheaters, two 100 kw. steam alternators, switchboard, instruments, steel chimney, poles, overhead wiring, transformers, meters, &c. Specifications from Prof. W. Buchanan, 75, Louis Botha-avenue, Johannesburg, or the Town Clerk, Middelburg.

St. Pancras (London) Borough Council has ordered a second 3,000 kw Ljungstrom turbine set from the Brush Electrical Engineering Company at £24,450.

Gravesend Corporation has accepted the tender of John Thompson & Company for the supply and erection of boilers at £16,015, and that of the British Thomson-Houston Company for switchgear at £2,364.

Leeds Tramways Committee has accepted the tender of the British Thomson-Houston Company for a 1,500 kw. rotary converter equipment, and the Electricity Committee has ordered 14 miles of cable from W. T. Henley's Telegraph Works Company at £31,917, and 6 miles of cable from the Enfield Ediswan Cable Works at £3,449. 10s.

Hammersmith (London) Borough Council are recommended to accept the tender of the British Electric Transformer Company for the supply of four 1,000 kw. and two 500 kw. single-phase transformers and three 500 kw. three-phase transformers (mesh star connected) at £8,005. The times quoted for delivery range from 30 to 76 weeks. Owing to the high prices quoted for switchgear and the unduly long periods required for delivery it has been decided to amend the specification and to invite fresh offers. In regard to cable, the Committee has also decided to accept tenders for only some of the items for which quotations were invited, and the following are now recommended for acceptance: Western Electric Company for 5,000 yds. of 0·15 e.h.t. six-core cable, 2,000 yds. of 0·15 l.t. three-core cable and 1,000 yds. of 0·05 l.t. concentric cable; Enfield Ediswan Cable Works, Ltd., 2,000 yds. of 0·1 e.h.t. and 1,000 yds. of 0·25 e.h.t. concentric cable, 2,000 yds. of 0·1 l.t. three-core cable and 3,000 yds. of 7/22 l.t. twin cable; Doulton & Company have secured the order for 2,000 yds. of one-way 3 in. cable ducts, and Sankey & Company for 4,000 yds. of four-way 4 in., 1,000 yds. of three-way 3½ in., and 2,000 yds. of two-way 3½ in., cable ducts.

Companies' Reports, &c.

Notice is given that 450 certificates of the Submarine Cables' Trust will be redeemed from the surplus funds of the Trust, by a drawing which will take place on the 3rd prox., at 2.30 p.m., at 34, Electra House, Finsbury Pavement, London, E.C. 2, for payment at £120 per certificate, at Messrs. Glyn, Mills, Currie & Company, 67, Lombard-street, E.C. 3.

The Eastern Telegraph Company, Ltd., announce that, owing to unavoidable delays in obtaining the necessary returns from foreign stations and administrations, it will be impossible to present the accounts duly audited in respect of the year ending Dec. 31, 1919, during the month of May, when it has been usual to hold the annual general meeting. As already intimated, the directors decided to pay on May 15 next a final dividend for 1919 of 5½ per cent. on the ordinary stock. This will make the distribution for the year 10 per cent. tax free, against a dividend of 6 per cent., and a bonus of 2 per cent., or a total distribution of 8 per cent. for the previous year. The usual distribution at the rate of 3½ per cent. per annum, less tax, on the preference stock for the first quarter of 1920 will be paid on the same date. The transfer books of the ordinary stock will be closed from May 6 to 14 inclusive. The Company also announce the payment by warrants on May 1 of interest for the half-year ending the 30th inst. on their 4 per cent. mortgage debenture stock. The transfer books of the stock will be closed from the 26th to 30th inst.

Mr. Douglas Vickers, who presided over the meeting of Vickers, Ltd., on the 22nd inst., reported that there were now 53,250 members registered, the large increase being due to the acquisition of the Metropolitan Carriage, Wagon & Finance Company, Taylor Bros. & Company and W. T. Glover & Company. As the result of the purchase of the Metropolitan Wagon Company, the British Westinghouse Company passed under their control, with its connections in France and Italy. For certain reasons, the name was subsequently changed to the Metropolitan-Vickers Electrical Company. Relations with the American Westinghouse Company, however, still continued on the most friendly lines, and further connections had been made with Brown, Boveri & Company; with that combination they would have the benefit of a world-wide experience in the design of a large range of materials which had been proved to suit both European practice and that of other countries. The electrical works of the company were very full of work. Taking the year as a whole, it had been one of extreme difficulty, due to changes in trade, shortage of materials, reduction in working hours and repeated increases in wages.

The annual meeting of the Brush Electrical Engineering Company, Ltd., was held on Monday, when the chairman (Mr. E. Garcke) stated that the output during the past year had been large in both the rolling stock and engineering departments, and the amount of work in hand, as well as orders flowing in, were considerable. The improvement in the business was due mainly to the development of their standard lines of manufacture. During 1919 they had increased their capacity for building railway, tramway and other rolling stock. There had been great development in the orders for Brush-Ljungstrom turbo-alternators and auxiliaries, and the demand for the plant was now only limited by their capacity to supply. The orders received this year exceeded by more than 75 per cent. those for the corresponding period of 1919, and already amounted to more than half the total for 1919, a record year. They had authorised the erection of a large additional factory to be devoted to the economical production of Brush-Ljungstrom sets. They had been much handicapped by labour unrest and the continual advances in wages and materials. Their various extensions to factory and other buildings, plant and tools called for more capital, and the increase in volume of business required a larger working capital. They had decided, therefore, to increase the authorised capital from £253,000 to £600,000 by the creation of further ordinary shares. The report was adopted, and at an extraordinary general meeting subsequently held a resolution was passed giving powers to capitalise part of the reserves.

English Electric Company, Ltd.

The annual general meeting of this company was held on Wednesday, Sir Charles E. Ellis, G.B.E., K.C.B. (Chairman of the Company), presiding.

The Chairman, in moving the adoption of the directors' report and accounts, said: Before going into the questions arising on the report and balance sheet, I should like to touch briefly on a subject which affects not only the welfare of this Company, but industry generally. Last week, the Chancellor of the Exchequer published his proposals regarding taxation for the ensuing year. Strong protests have already reached him concerning the effect of such proposals upon industry, and particularly the continuation of the Excess Profits Tax. It is imperative that definite steps should at once be taken to prepare in time for the next Budget some new scheme, which will not react so unfavourably upon young and only partially developed industries such as our own, the electrical industry, which, after long years of unfair competition at home and abroad, is just beginning to raise its head.

After dealing with the figures in the report (abstracted in our last issue), the chairman went on to say: We were fortunate in issuing our debentures in August 1919, on terms which compare favourably with current rates for borrowing. The entire expenses of the debenture issue, amounting to £115,660, and also the preliminary expenses (amounting to £17,385) have been written off. Your Board consider it is satisfactory to be in a position to place a substantial sum to reserve in the first year. The profits of our subsidiary companies have, however, been charged with proper depreciation, before taking them into our accounts. At the end of last year the Company was in the main a holding company. In next year's accounts it is anticipated that certain assets in the subsidiary companies will have been transferred or leased to the Company. We have already made some progress in this direction. Dick, Kerr & Company, Ltd., are in liquidation, and we hope the liquidator will be in a position to transfer the assets during the current year. Leases in favour of the Company of two of the other works have been prepared. The most important transactions since the formation of the Company are as follows: first, the purchase of the Stafford Works of Siemens Bros. Dynamo Works, with the engineering and sales organisation. This not only provides an immediate increase of manufacturing capacity, but also provides a working arrangement with the parent company—Siemens Bros. & Company, Ltd.—covering the supply on favourable terms of their specialities. Secondly, an amalgamation of the contract department of Dick, Kerr & Company with that of J. G. White & Company, in the form of the Consolidated Construction Company, which eliminates one of the strongest competitors of the past. This new company will be useful and I hope profitable in carrying out civil engineering work. In the third place, a subsidiary company, the English Electric Supplies, Ltd., has been formed to take over the assets of the Britannia Lamp & Accessories Company, Ltd., which formerly marketed incandescent lamps and other accessory electrical apparatus on behalf of Dick, Kerr & Company, and arrangements have been made for considerably expanding the variety of this class of manufacture. Finally, a negative transaction is the disposal of the Scotstoun Works of the Coventry Ordnance Works.

There are certain indications that the relations between employers and employed are becoming less strained. The recent decision of the National Federation of General Workers to accept payment by results, together with the agreement of the Amalgamated Society of Engineers to submit the question to a ballot, are favourable portents for the future. Generally speaking, the year has been mainly devoted to the consolidation and organisation of the different units. During last year very little real production of electrical and allied apparatus took place. The earlier part of the year was devoted to re-arrangement of shops and re-modelling in design, and we were just getting on to a producing basis when the unfortunate strike of moulders found us with none of the stocks of our raw material which would have been available in normal times, and therefore we were under the necessity of immediately reducing output by in some cases discharge of employees, and in others the working of short hours. The effect still remains even after 13 weeks since the settlement. We are, perhaps, more fortunate than some in that we have three excellent foundries in our group, but they are handicapped by the shorter hours worked and the fact that piecework arrangements have not yet been agreed to.

Our orders are sufficient to keep all our 10,000 employees fully employed for 18 months if only we can get the necessary material; indeed, if material were forthcoming we could double our pay roll without any risk of running short of work. We have now on our books orders amounting to £4,750,000, and the bulk of it may be termed quick turnover and repetition work, the demand for which is practically unlimited if only we can secure production sufficiently expeditious to compete with America and other foreign makers. Abroad we have not been idle. The manufacturing arrangements made by Dick, Kerr & Company, with the Constructions Electriques du Rhone in France, and the Toyo Denki in Japan are being taken over and considerable expansion has taken place, especially in the case of the French Company, now known as Constructions Electriques de France, with a subsidiary company, known as Les Constructions Electriques de Belgique. The combined capital of these two concerns is 90,000,000 francs, and we have granted them extended manufacturing rights under our various designs and patents. In Australia the English Electric Company of Australia, Ltd., has been formed with a capital of £600,000, all subscribed locally. This Company is erecting new shops especially for production under our various designs. Similar arrangements will be entered into in other Dominions when opportunity offers.

Referring to the Electricity (Supply) Act, he said: It is clear that the attainment of the cheapest possible national supply of electricity will involve *inter alia* the construction of generating stations containing larger units and giving greater total output than have been commonly found in this country in the past. This is a task which will give full scope for the designing and manufacturing skill of our electrical industry. We are already engaged on a comprehensive contract for the construction and equipment at Blackburn of what, from its strategic position and its ultimate destiny as the supplier of a wide industrial area, may be described as the first of the super-power stations. We look forward to the progressive extension of railway electrification. At least one important main line electrification has already been decided on. In the next 10 years we shall see important developments in electric traction. Abroad, as at home, wherever we turn we find in progress or in contemplation the extended application of electric power to industry or to transport. Where, as in India, abundant water-power exists, hydro-electric schemes are being developed. In South Africa an important scheme of railway electrification is contemplated. Everywhere the electric drive is being introduced into collieries and mineral works, cotton and jute-mills, oil-fields and sugar plantations, and various other industries. The Constructions Electriques de France, have recently obtained large contracts, spread over a term of years, for the electrification of the greater part of the system of the Chemins de Fer du Midi.

The report and accounts were adopted and the dividends set out in the report confirmed.

Sir Claud T. Cayley, Mr. W. L. Hichens and Mr. John Sampson were re-elected as directors, and the election of Sir John A. F. Aspinall and Lord Merton was confirmed.

Forty Years Ago.

(The Electrician, May 1, 1880.)

Quebec.—All the necessary apparatus has been fixed up in the Parliament House, Quebec, for lighting the Council Chamber with the electric light. The trial is to be made immediately.

The Telephone Companies.—Col. Webber, R.E., formerly of the Postal Telegraph Service, is, we understand, likely to take a prominent position in the management of the telephone companies working respectively the patents of Bell and Edison. These companies, it is rumoured, will probably effect an amalgamation on the basis of paying a royalty to the Postmaster-General.

Quadruplex in Australia.—Mr. Cracknell, Superintendent of Telegraphs in Sydney, with Mr. McGauran, of Melbourne, has introduced the quadruplex system of telegraphy, by which four messages can be sent on one wire simultaneously. The trials made answer perfectly, and the system will be very shortly introduced into Sydney, effecting a great economy and reducing the time for a telegram between the two cities to three minutes.

Aldersgate Street Station.—It would appear that the electric lighting of the Metropolitan Aldersgate-street station during the last seven months has given satisfaction, since the railway company has determined to adopt it for several other stations as well. The light will be temporarily discontinued in order that the Electric Generator & Light Company, who are supplying it, may make the necessary arrangements for the permanent lighting.

F.R.S.—At the special request of the Committee of the Royal Society, Prof. D. E. Hughes has allowed his name to be enrolled as a candidate for the Fellowship of the Royal Society. The action of the Committee in this matter does them great credit, and the election of the electrician who, besides other useful researches, has enriched science with the type-printing telegraph, the microphone and induction balance will confer additional lustre on the Society.

The Albert Medal.—The Council of the Society of Arts is now about to consider the award of this medal for the present year. We notice that, of the 17 recipients of this tribute to "distinguished merit in promoting arts, manufactures or commerce," five are electricians—viz., Prof. Faraday, Sir W. Fothergill Cooke and Sir C. Wheatstone (these two names being bracketed together in one award), Dr. C. W. Siemens, and Sir William Thomson.

An Electrician in Parliament.—Mr. Bernard C. Molloy, just elected as representative for King's County, is a gentleman well known in connection with some of the applications of chemical and electrical science. He was several years ago elected an Associate of the Society of Telegraph Engineers; and, in conjunction with Mr. Desmond FitzGerald, he took up the question of the production and use as a depolarising agent of solutions of chromic acid in a comparatively concentrated form, and containing but a small proportion, if any, of the potash salt, which, in the ordinary "bichromate solution," has so inconvenient a tendency to crystallisation. The "multi-carbon battery," intended to be used with these solutions, is probably the most convenient and efficient when currents of great power require to be maintained in action for a considerable period of time. At the meeting of the British Association at Dublin, Mr. Molloy read a most valuable Paper on the regeneration of nitric acid from the lower oxides of nitrogen, a subject which at one time, at least, would have been of special interest to the electrician.

Prices of Metals, Chemicals, &c.

Tuesday, April 27.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£110 0 0	—	£1 0 0
Electro Wirebars...	,,	£113 0 0	—	—
H.C. wire basis......	per lb.	1s. 3⅝d.	¼d.	—
Sheet	,,	1s. 5½d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8⅝d.	¼d.	—
Brass 60/40—				
Rod, basis	,,	0s. 11⅜d.	⅜d.	—
Sheet, basis	,,	1s. 3¾d.	—	—
Wire, basis	,,	1s. 3¾d.	—	—
Iron—				
Cleveland Warrants	per ton	£10 7 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£48 10 0	—	—
Lead Pig—				
English	,,	£42 10 0	£2 10 0	—
Foreign or colonial	,,	40 10 0	£3 10 0	—
Tin—Ingot	,,	347 5 0	—	£3 5 0
Wire, basis	per lb.	0 4 2	—	3d.

Salammoniac.—Per cwt. 105s.–160s.

Sulphur (Flowers).—Per ton £22.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton. £8 8s. 9d.

Copper Sulphate.—Per ton £48

Boric Acid (Crystals)—Per ton £74

Carbon Bisulphide.—Per ton £56.

Sodium Bichromate.—Per lb. 9d

Sodium Chlorate—Per lb. 5½d.

Rubber.—Para fine, 2s. 2½d.; plantation 1st. latex 2s. 1½d. to 2s. 3d. lb

Shellac.—T.N. Orange, 525s. to 530s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics":—"The Air Ministry Competitions, 1920"; "Radiators and Cooling Systems for Aircraft Engines," lecture by Capt. R. N. Liptrot, B.A.

"The Cabinet Maker":—"Cane Furniture for Public Tearooms"; "Flemish Renaissence Chairs"; and "Measured Drawings of Recent Acquisitions at South Kensington."

"Chemical Age":—"Chemical Engineering Group: Special Reports of Third Conference at Birmingham"; and "Fire Dangers in Chemical Factories (II.)."

"Fruit-Grower":—"The Modern Wonder Plant: The Potato"; "New Food Control Policy"; "Money for Agriculture."

"Gas World":—A special section treating of the By Product Coking of Coal; Gas Apparatus used in the manufacture of fuses for use in the war; and questions set in the City and Guilds of London examination in Gas Engineering.

"Hardware Trade Journal":—"The Hardening of Screw Gauges"; "Grinding Lawn Mowers by Hand"; "Some Fundamental Aspects of Heat Treatment."

"Ways and Means": "Economic Conditions in Germany," by Captain Wedgwood Benn, D.S.O., D.F.C., M.P.; "Economic Leadership," by W. Henderson Pringle; and "Co-partnership in the West Riding," by H. Cooper.

Arrangements for the Week.

FRIDAY, April 30th (to-day).

Wireless Society of London.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "A Wireless Call Device," by Major Basil Binyon, O.B.E.

N.-East Coast Institution of Engineers and Shipbuilders.

6.15 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "A Modern Power Station and its Development," by Mr. J. S. Watson.

Institution of Electrical Engineers, Students' Meeting.

7 p.m. At Faraday House, Southampton-row, London, W.C. Paper on "Tidal Power," by Mr. J. E. Holmstrom.

Institution of Mechanical Engineers.

7 p.m. At Storey's Gate, London, S.W. Discussion, to be opened by Mr. A. P. Bale, on Suggested Means of Improving and Increasing the Services of the Institution to Members.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Social Evening.

SATURDAY, May 1st.

London Association of Foremen Engineers.

6 p.m. At Cannon-street Hotel, London, E.C. Sixty-seventh Anniversary Festival.

MONDAY, May 3rd.

Institution of Electrical Engineers, Western Centre.

6.30 p.m. At the Public Library, Alexandra-road, Swansea. Kelvin lecture will be delivered on "Modern Marine Problems," by Dr. C. V. Drysdale.

TUESDAY, May 4th.

Röntgen Society.

8.15 p.m. At 11, Chandos-street, Cavendish-square, London, W. Paper on "Some Problems in the Action of Radiation upon Tissues," by Prof. S. Russ, D.Sc., and Demonstrations on "The Transmission of Speech by Light," by Prof. A. O. Rankine, O.B.E., D.Sc., and "New Portable Viewing Lantern," by Dr. H. A. Eccles.

FRIDAY, May 7th.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Pulverised Fuel," by Mr. J. G. McBryde.

Royal Institution.

9 p.m. At Albemarle-street, Piccadilly, London, W. Discourse on "The Blue Sky and the Optical Properties of Air," by the Right Hon. Lord Rayleigh, Sc.D., F.R.S.

The Editorial, Advertisement and Publishing Offices of "The Electrician" *are at* 8, *Bouverie Street, London, E.C.4. Telegrams: Benbrotric, Fleet, London. Telephone: City* 9853 (*4 lines*).

The subscription to "The Electrician" *is* £2. 12. 0. *per annum in the United Kingdom, and* £2. 14. 0. *per annum Abroad. Advertisement Rates can be obtained on application to the Manager. Advertisement copy and blocks should be received on the Friday preceding date of publication.*

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,190. [Vol. No. 19. LXXXIV.] FRIDAY, MAY 7, 1920. PRICE ONE SHILLING. By Post, 1s. 1d. Abroad, 1s. 2d.

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Notes.

The Institution Council.

DURING last week-end members of the Institution of Electrical Engineers received their ballot papers for the election of the Council for 1920-21. These papers must be returned on or before to-morrow. In addition to the nominations put forward by the Council, which were given in our issue of April 9th, 1920, three other members have been nominated. These are Mr. R. F. FERGUSSON, borough electrical engineer, Hastings, Mr. A. H. MARSHALL, constructional engineer, Cleveland & Durham Electric Power Company, and Mr. C. VERNIER, chief mains engineer, Newcastle-upon-Tyne Electric Supply Company. It will, therefore, be seen if these nominations are accepted, to the exclusion of an equal number of the Council's nominees, the supply section of the industry will have a large, not to say a preponderating, representation. We do not propose to advise members how to vote for the time is so short, but we do appeal to all who have not already done so to send in their ballot papers without delay.

The Disabilities of Provisional Members.

A LETTER from Mr. R. F. LONGMAN, which we publish in this issue, raises a point which, though not new, is still of some interest. He complains that of the Council's new nominations nine out of twelve live in the London area. This territorial idea can, however, be overdone. The object in electing a Council should be to obtain the best men available irrespective of their place of residence. The provinces are inclined to be inordinately jealous of London, which is another mistake and very unreasonable. For as all chairmen of Territorial Centres are *ex-officio* members of the Council during their term of office, there is little chance of provincial affairs being neglected. Indeed, the tendency is rather the other way. With the other criticism made by Mr. LONGMAN we agree. It is obviously unfair that provincial members of the Council should be asked to bear the heavy personal expense involved in the proper discharge of their duties. Surely it is time that these expenses were borne by the Institution.

The Electricity (Supply) Act in the Severn Valley.

DURING the past year or so the Severn Valley has been famous for costly experiments in ship building by Government Departments. It is now to obtain further fame by being the site of the first district established under Clause 5 of the Electricity (Supply) Act. The area thus constituted will contain within its boundaries Bristol, Bath, Gloucester, Swindon, Cheltenham, Hereford, Monmouth, Taunton and Chepstow. It thus includes towns where there is a good present or prospective power load, such as Bristol, Gloucester and Swindon, towns where the domestic load is being developed, such as Bath and Cheltenham, and large areas where there is every chance of obtaining a good agricultural load. This linking-up scheme, for that is what it amounts to, will be a great assistance to existing stations, and enable development throughout the area to be effected on more progressive lines than has been possible in the past. In time this area will have its capital station, but that is for the future rather than the present. Representations by those interested must be made before the end of July, after which the statutory inquiry will be held. This first example of the Act in operation will be watched with interest.

The Largest Electrically-Driven Rolling Mill.

THERE is something extraordinarily impressive about mere size. For that reason we are apt to presume the Forth Bridge represents a higher achievement in human endeavour than a delicately made balance that can weigh a fly's leg. The truth is that the two are not comparable, and it is unjust to the designer and manufacturer of either to attempt to belittle one at the expense of the other. Nor is there any reason why we should not equally admire both. This time it is in the turn of the big equipment. On another page of this issue we give an account of an electrically-driven reversing rolling mill which has recently been erected at Messrs. Dorman and Long's Warrenby Works, near Redcar. It is certainly the largest mill so driven in this country, and is probably the largest in the world. Its maximum peak load corresponds to a torque of approximately 1,200 tons-ft., or to 20,500 H.P. when running at 40 revs. per min. The motor can be reversed from this speed in one direction to the same speed in the other direction in less than 3 seconds. The weight of the motor is 420 tons, and the weight of the revolving part is 120 tons. The journals are 30 in. in diameter. The motor is supplied from a generator set operating on a modification of the Ilgner system, the principal difference being that differential shunt field windings are used to decrease the time required for the field generator field to build up or die away, and consequently the time required to reverse the mill motor is also shortened. These windings also eliminate "creeping" by neutralising any residual flux in either exciter or main generator, and prevent the main generator voltage from increasing excessively on reversal when the motor is running light. But no bald description and no vivid pen picture either for that matter can give a true idea of this mighty machine at work. It is trite to say that it suggests power. It does a great deal more than that. It engenders an overwhelming admiration for the successful efforts of its designers and builders and a sincere conviction that the enterprise of British engineers is still very much alive.

Two Conventions and a Difference.

An interesting example of the difference between British and American methods is to be found by comparing the programmes of the Annual Conventions of the Incorporated Municipal Electrical Association and of the National Electric Light Association. In 1920 both these conventions will be held at holiday resorts, the former at Ilkley and the latter at Passadena, California. In both cases a portion of the time will be devoted to entertainments and excursions, and a portion also to meetings at which Papers on technical problems will be read and discussed. But it is only on looking more closely into the programmes that it will be seen how superficial this resemblance is. At the I.M.E.A. Convention Mr. Roles will deliver his presidential address, three Papers will be read, and there will be one business meeting. At the Passadena Convention, which is open for practically the same time, there are 16 addresses, five Papers, and no less than 73 reports submitted for discussion, though it is fair to add that a number of these will be presented to sectional and not to plenary meetings. Bodily dyspepsia is, we believe, one of the most prevalent human troubles in the United States. We should not be surprised to hear that the next most prevalent disease is mental dyspepsia, and that the percentage of sufferers among members of the National Electric Light Association is exceptionally high. The advance bulletin says delegates "have before them four days of the busiest kind of work with just enough recreation and entertainment dovetailed in to keep them from going stale." This may be true in the States, it certainly would not be true here, where those attending would not only go stale, but collapse altogether.

What the Station Engineer Wants.

It is really a sign of development that at conventions in this country less and less time should be devoted to formal meetings. For the station engineer especially to overcrowd the programme with formal meetings is quite the wrong policy. In many cases the Annual Convention of the Incorporated Municipal Electrical Association affords one of the very few occasions on which the engineer of an electricity supply undertaking can "talk shop" on equal terms. He has his own special troubles and problems upon which little light will probably be shone by the Papers and discussions, but which may be solved in a few minutes' chat with a colleague. A station engineer, nowadays more than ever, is a busy man. The Convention, if not a holiday, is a pleasant break away from routine. It is held in the summer. It is desirable, therefore, that as much time should be spent out of doors in unofficial talks. We are glad to see that this policy is to be carried a step further at the summer meeting of the Institution of Electrical Engineers, in which no Papers will be presented, the whole time being devoted to visits to works and entertainments of a more social character. This is not waste of time.

The Institute of Physics.

Our ever-increasing knowledge of material phenomena means a constant re-adjustment of what at one time seemed permanent boundaries between the various sciences. As physics in one direction tends more and more towards chemistry, so chemistry merges in biology and biology in physics. In physics, especially, the frontiers are ill-defined, a state of things which must encourage specialisation, and in the usual course the formation of Societies dealing particularly with one small branch of the subject. Such multiplication of Societies is, however, to be deplored. On the professional side the wider the field of any Society the wider its appeal and the greater its value to its members. We are, therefore, glad to see, that, with the co-operation of the Faraday Society, the Optical Society, the Physical Society of London, and, we understand, also the Royal Microscopical Society, an Institute of Physics is to be formed to secure recognition of the value of physicists in present-day life by co-operative action throughout the country. The constituting Societies will not for the present disappear, though doubtless this preliminary co-operation will lead gradually to closer co-ordination. We certainly hope so. There will be three classes of members: ordinary members, associates and fellows. For membership of the two latter classes full professional qualifications will be required. The first President of the Institute is Sir Richard Glazebrook; Sir Robert Hadfield is Treasurer and Prof. A. W. Porter, Honorary Secretary. The other members of the Board are: Dr. H. S. Allen, Inst.-Commander T. Y. Baker, R.N., Prof. F. J. Cheshire, Dr. R. S. Clay, Mr. W. R. Cooper, Prof. W. H. Eccles, Major E. O. Henrici, Dr. C. H. Lees, Mr. C. C. Paterson, Major C. E. S. Phillips, Dr. E. H. Rayner, Mr. T. Smith and Mr. R. S. Whipple. Mr. F. S. Spiers has been appointed Secretary, with offices at 10, Essex-street, Strand, W.C. 2. Members of the Institute who are also members of more than one of the co-operating Societies will obtain a reduction in the subscription to those Societies. We are glad to learn that promises of support have been received from leading physicists and we wish the new Institute the greatest success.

Artificial Lighting of Churches.

In his Paper recently read before the Illuminating Engineering Society, Mr. J. Darch emphasised some practical aspects of church lighting—that is, the importance of avoiding glare from exposed lights falling within the direct range of view of the congregation (which not infrequently have a soporific effect), and the need for sufficient illumination for the worshippers to read the text in books, often printed in undesirably small type. He also made some useful suggestions on pulpit lighting, the aim of which should be to concentrate the attention of the congregation on the preacher's face, as well as enabling him to read the notes for his sermon. Many of these suggestions may be considered "common sense," but they are still not commonly applied in churches. Mr. Darch's views on the exclusion of glare seem somewhat extreme (though this is possibly a fault in the right direction), and he is evidently strongly inclined to indirect methods of lighting. Some of the examples he showed of this form of illumination were excellent, but it is clear that they cannot be applied in all churches. In modern buildings, we grant, illumination on modern lines is necessary. But we confess to some sympathy with the architect who urged that "mystery and imagination are the greatest aids to architectural effect." The vast cathedrals of France and Italy, for example, could hardly be lighted on approved modern lines, and the nature of the worship there carried on scarcely demands a high order of illumination. Again, as was pointed out in the discussion, there are some churches where the influence of tradition plays a most important role. Two opposite cases were synogogues, one of which insists to this day on retaining the exact wax candles originally employed, while the other has adopted up-to-date lighting, with the proviso that the original oriental style shall be reproduced in the new fittings. Our great complaint against the authorities responsible for buildings of architectural distinction is that when they at length unbend and allow the introduction of electric light, they often seem to abandon all hope of preserving the best traits of the old lighting, and allow hopelessly incongruous fittings to be installed. Ecclesiastical authorities might study this question with advantage.

Telephone Charges.

We are very much afraid that the appointment by the Chancellor of the Exchequer of a Committee to report on telephone charges will only have one result—the increase of those charges. Increases in the prices of all sorts of commodities and services is a feature of our present existence which we have to face with such equanimity as we can muster. In most cases there are adequate reasons for a part at least of these increases, such as higher wages and shortage of raw materials, combined with a legitimate desire that the profits should not fall below their pre-war level. But to ensure this in every privately-owned concern close regard must be paid to the reduction of unnecessary expenses, while at the same time the selling organisation must be nourished because only in this way will greater revenue accrue. We are not among those who criticise the Post Office Telephone Service in season and out of season. Within its limits it does its best. But it is hampered more than perhaps its most enlightened officials realise by the fact that it has not to make a profit, and by a reluctance on the part of the controlling Treasury element to develop a selling organisation on modern lines. No one has ever seen an advertisement of the Telephone Service, and that absence in itself expresses the attitude of the Post Office to the selling side of their business. The present times are not normal, it is true, for the laying of new cables, the erection of fresh exchanges and all the other signs of a healthy development ceased during the war and the Post Office engineering department are still struggling with the arrears, and to catch up the demands of justly incensed potential subscribers. But that state of things is not going to last for ever. Increased rates will discourage many new subscribers, the capital grudgingly spent on extensions will become unproductive and the telephone system will become a candidate for State aid at no distant date, unless a radical change in its administration is made. It is not a question of efficiency of service, but of policy. A Derby winner cannot be trained on grass, neither can a telephone department successfully develop without capital and the employment of modern commercial methods.

Coal Prices.

The Coal Controller has been trying to play the home and exports markets off against one another with the result that the tonnage exported at a high price has gradually fallen and the profits therefrom which could be set off against the loss on home consumed coal have been correspondingly reduced. The rebate allowed on the coal consumed for domestic purposes is, therefore, shortly to disappear in practice if not in theory. We hope for the sake of station engineers it will disappear in both, while the consumer will not really suffer. For instance, a consumer living in a district which enjoys electric lighting at 10d. per unit obtains a rebate of 9d. for every pound thus expended, or $\frac{3}{8}$d. per unit. We do not suggest that this case is typical, for in some industrial areas, where the lighting consumer is benefiting at the expense of the power consumer, the rebate is probably more. But we do suggest that the whole thing is not and never was worth while. It will be much better in every way for the country to have its coal "de-controlled," even if it has temporarily to pay more for it. We have had enough of controllers and especially of the Coal Controller.

The Prolongation of Patents.

The Patents and Designs Act of 1919, which extended the normal life of patents from 14 to 16 years, amended the provisions of the Act of 1907 as to an extension of the term of patents and enables an owner of a patent, who was prevented from exploiting his invention owing to the war, to apply for a prolongation of his monopoly. Two important decisions on this question have recently been given by Mr. Justice Sargant. In the first case the owner of a patent, which would expire under the 1907 Act in July, 1920, presented a petition for the prolongation of the term. In the meantime the 1919 Act had been passed, making 16 years the usual term of all patents. In the course of his judgment Mr. Justice Sargant pointed out that an application for prolongation two years before expiration would, under the ordinary practice, be refused as premature. The great reason for extending the term of a patent was that the patentee had not been adequately remunerated; but the question whether he had been so remunerated could not be entertained until nearly the end of the original period for which the patent was granted. As no special ground for departing from the ordinary practice was shown the petition was adjourned, with liberty to apply to restore it later on.

Patents and Controlled Establishments.

In the second case, Mr. W. Brown, who had obtained a patent for an invention relating to improvements in hopper barges and dredgers, which expired on December 28, 1916, applied for an extension because the firm who had built vessels embodying the invention up to the beginning of the war, became a controlled establishment in 1915, and only one dredger in accordance with the patent was completed thereafter. It was alleged that the inventor had suffered loss owing to war, and the judge decided that the case came under sec. 7 (3) of the 1919 Act, which was inserted for the purpose of protecting patentees who, by reason of the war, had suffered loss or damage. He held that the Court had jurisdiction to deal with an application, made by originating summons, for an extension of the time, although the patent had expired. Our readers will therefore be glad to learn that patentees whose patents expired during the war, and who, prior to their expiration, had suffered loss or damage by reason of the war, are allowed to apply by way of originating summons for an extension of the term of their patent rights. This is a step in the right direction.

Gas-filled Lamps and Arc Lamps.

The advent of the gas-filled ("half-watt") lamp, prior to the war was already threatening the position of the arc lamp in many fields of lighting, and circumstances during the war period, if not exactly favourable to the gas-filled lamp, were for the time being practically fatal to the arc lamp. Restrictions on public lighting operated in both cases, though the gas-filled lamp was possibly less affected, owing to the comparative ease with which it could be screened; but during the war carbons were practically unobtainable. So far as one can judge from present events, gas-filled lamps seem likely to take the place of arc lamps in many fields. In industrial lighting for example, the war has made manufacturers familiar with the advantages of properly spaced gas-filled lamps for overhead lighting (and such gas-filled lamps as were available were used mainly for munitions and industrial establishments). In street-lighting the conversion of arc-lamp fittings to gas-filled lamps has made great headway. Carbons are still difficult to obtain and expensive, and the cost of labour in trimming, already a factor of consequence before the war, is now an even more influential element. One still sees calculations comparing the relative cost per candle-power of both types of lamps, and so far as the ordinary arc lamp is concerned the advantage almost certainly rests with the gas-filled lamp. But a point of even greater importance is the ease with which the latter can be fitted with reflectors of various types, promoting a better distribution of light, and still further increasing the advantage as regards illumination on the working plane. The position as regards the flame arc is not quite so clear. If adequate supplies of carbons are available this form of lighting may still be used in cases where large areas have to be lighted, and adequate overhead space is available. Several firms are said to have developed carbons which yield an efficiency in advance of that obtainable before the war, and this was already admittedly considerably above that of the best gas-filled lamp. Experience, however, teaches us to be wary of predictions of this kind. There are still possibilities of greater efficiencies in lamps of the arc type. On the other hand with more powerful units we may see similar advances in incandescent lamps, and we believe that there is no great technical obstacle to the production of candle-powers very much in excess of those available at present.

Long Distance Cable Telephony.

From the popular point of view one of the drawbacks of the increasing development of electrical engineering is a cessation of those discoveries which, whether they be epoch-making or not, are certainly spectacular. We have to advance slowly and carefully rather than by leaps and bounds, and that of course is dull. To replace the lack of inventions in the electrical world our daily contemporaries have to satisfy that craving for "stunts," which is now so much a feature of daily journalism, by resorting to inventions of another kind, of which class of discovery the recent hypothetical signals from Mars are a typical example. That solution is not open to us. Nevertheless, even in these dull days there are occasions when something more than usually interesting comes to light, and when the technical Press may quietly indulge in a little self-congratulation over an addition to our knowledge in one or other of the branches of electrical engineering. This we are able to do this week, for the Paper, of which the first part will be found on another page of this issue, by Messrs. Bancroft Gherardi and F. B. Jewett upon telephone repeaters, recently read before the American Institute of Electrical Engineers, deals with a subject, the importance of which in its bearing upon the future of telephony can hardly be overestimated.

A Landmark in the Progress of Telephony.

Although from time to time reference has been made in these columns to the feats in long distance wire telephony which have been accomplished, comparatively little information as to the details of the methods employed have been available until now. The Gherardi-Jewett Paper takes us behind the scenes, and in doing so records a landmark in the progress of telephony, a landmark of such importance that all future development in long distance wire telephony must be measured from it.

The Limits of the Telephone Line.

Up to the present time the limiting factor in the extension of the range of telephone transmission has been the telephone line. Satisfactory conversation has been easily and cheaply obtained over moderate distances. With increasing distance, however, the electrical and physical difficulties as well as the expense multiply, until further expansion is prevented by one or both of the above factors. One of the main problems of modern telephone engineering has thus been to enable the line to keep pace with the demands made upon it by the fast increasing commercial use of the telephone. A great stride in this direction was made 20 years ago when the introduction of the loading coil according to the Pupin system greatly increased the commercial telephone range. The development of paper-insulated cable of duplex or multiple twin construction has also contributed to this end by making practicable the use of phantom or superimposed circuits, and thus increasing the circuit capacity of a given line plant by 50 per cent.

A Problem of Many Years' Standing.

The possibility of using a telephone repeater upon long distance connections and by this means achieving still greater economy in line plant has been present in the minds of telephone engineers for some years; but the technical difficulties of the subject have been so considerable that until the arrival of the thermionic amplifier very little commercial success was obtained. The problem of the development of the telephone repeater has been two-fold, firstly the production of a commercially satisfactory amplifying element, and secondly, the application of this to telephone circuits under ordinary service conditions. That the work involved in the solution of this problem has been considerable, both in extent and intricacy will be appreciated from a review of the Paper. The great fact, however, is that it has been solved; and the telephone repeater is now a commercial instrument.

What the Discovery Means.

The effect of this upon the future policy of telephone engineers can be appreciated from the following quotation from the Paper :—"The tools thus at our disposal are of such a character as to permit of our forecasting the changes which their use is likely to produce in the evolutionary growth of the telephone plant. When combined with the benefits to be derived from the loading of cable circuits, the use of the practically perfect repeaters now available puts an entirely different aspect on many of the problems which have confronted the telephone engineer in the past. Not only will there be the opportunity to utilise smaller gauge wires than has hitherto been possible, but the economical field for underground and overhead toll cables will be greatly extended into the region which it has heretofore been possible to serve only with some form of open wire construction. Viewed from the standpoint of continuity of service alone, this is an advantage of almost inestimable value. Further, the range of reliable and commercially possible long distance telephony will be very greatly extended."

American v. British Appreciation of Research.

There are two aspects of this subject which are worthy of particular comment. The importance of applied scientific research to the future development of engineering in the service of mankind has once more been definitely demonstrated. American enterprise has, ever since the inception of commercial telephony, been largely responsible for the commercial development of the many features contributing to the modern telephone art as practised throughout the world; and the development and application of the thermionic telephone repeater to commercial service is no exception to this rule. It must be admitted that much work has been done in Europe upon this particular problem by British engineers, with the result that during the war period thermionic repeaters were in use upon British circuits both in this country and overseas. It is also true that the early years of the war period have hindered development in this country to an extent which is hardly realised in America, but in spite of this it is hardly possible to doubt that American appreciation of the value of industrial scientific research as compared with the British attitude towards the same subject has been a very great factor in determining America's present leading position in telephony.

The International Aspect.

The national aspect in this case is, however, of less importance than the international. There is probably no factor of greater importance in the preservation of good international relations than facilities for intercommunication between the people of different countries. The introduction of the thermionic repeater into the sphere of practical telephony means a great step in this direction, and it is to be hoped that no country will be slow to realise this, least of all our own.

Fuel Economy.

Economy nowadays generally takes the form of a ruthless attack on the expenditure of some large amount, simply because it is large, and irrespective of how it is being employed. There is often great good in this policy, especially when it is applied to the finances of our new bureaucracy, but it is to be doubted whether in the long run these wholesale loppings show as great a result as those directed to the saving of a few pence on a very large number of items. There is a point, equally in Government departments and in commercial concerns, below which reduction of expenditure becomes harmful; and at the present time this point may easily be reached before the economies necessary for financial stability have been fully carried out.

This argument applies particularly to our methods of employing fuel. It is essential to use care in fuel consumption for reasons to which we have often referred, but at the same time an ever-increasing expenditure of fuel will be necessary as our trade increases and our industries expand; and to check that expenditure unreasonably would be most undesirable. More can be done in making sure that the fuel used is used in the best possible way.

How Small Savings can Help.

We are therefore glad to see that the Fuel Research Board, in their report for the years 1918 and 1919, rightly calls attention to the importance of the setting up by consumers themselves of a system of fuel control which will put an end to the waste that is at present going on. "There is no doubt," the report says, "that in the majority of industrial undertakings a reduction of 5 per cent. to 20 per cent. could be secured within a year at a relatively trifling expenditure on wages and small alterations in apparatus." It may perhaps be argued that this is beginning at the wrong end, and that it would be better for some central body to say exactly by what methods economies are to be obtained. But, however this may be, it is well to insist that any savings effected means money. "One ton of good coal burnt under the ideal conditions of the calorimeter should give about 30 million British thermal units. With coal costing 30 shillings per ton the cost of a million thermal units is therefore one shilling. Any process for the preparation of gaseous or liquid fuel necessarily involves the sacrifice of a proportion of the 30 million thermal units. In some cases this sacrifice amounts to as much as one third, or 10 million units," *i.e.*, to ten shillings per ton. It is advisable, therefore, that all processes employing coal should have this test applied to them, and that whether they are worth using or not under present conditions should be discovered. The programme which the Board propose to carry out seems well designed to this end.

The Domestic Employment of Coal.

The Board, however, have not confined themselves entirely to the utilisation of fuel for industrial purposes. The domestic employment of coal also receives attention, and the conclusions reached by the Board will come as a rude shock to those electrical and gas engineers who have inveighed for many years against the waste caused by the employment of the open fire for heating living rooms. The comfort and cheerfulness of this method of heating have been admitted, but its waste both of fuel and heat energy have been almost unanimously deplored. Tests carried out by Dr. Margaret Fishenden on behalf of the Manchester Air Pollution Board are designed to show that the radiant efficiency of coal fires of different types varies from 19½ to 25 per cent., and that when low temperature carbonisation cokes were used the efficiency rose to between 30 and 33 per cent., while there is the further advantage that with this type of fuel smaller diameter flues may be used owing to the absence of smoke, while control of the combustion is easier than in the case of coal.

The Passing of the Open Fire.

We are afraid, however, this vindication of the coal fire is not in accordance with facts. It is made subject to the important proviso that the grate used should be efficient, which many, even the majority of those at present installed, are not. In any event the open fire gives less heat where it is wanted at a greater cost than any other form of heating. Apart from economy the day of the open coal fire is over, and it is certain it will disappear for reasons quite other than those of efficiency pure and simple. It has kept its place so long because it is pleasant, and is believed to be healthy; and because the British public is conservative. It will continue for a time to keep its place in large houses and hotels where the employment of a domestic staff is still a possibility. But in smaller houses it will be gradually replaced by the electric radiator, and for a time by the gas fire, because the use of an open grate means some place for storing coal, a constant anxiety as to the cost and to the possibility of obtaining fresh supplies, labour in cleaning grates, making fires and disposing of the dirt made by fires, and generally the expenditure of time and energy which could be much better employed in doing something else. In addition, electric and gas fires can be turned on or off at a moment's notice, while there is no laying and no waiting for them to burn up, an operation which is often the worst of all.

Doubtless we preach the development of electricity for domestic purposes at all seasons (we do not say in season and out of season), but when it is so evident that the present conditions are driving the public sometimes almost unwillingly to adopt labour-saving methods it is obvious we have a chance of introducing electrical apparatus into the home in a way which we have never had before and may never have again. It is a chance which should be seized.

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(*Continued from p. 443.*)

Example.—We shall now proceed to analyse a winder for a shaft in which the inclination varies from 27 degrees at the bottom to 15 degrees at the top in six stages. The winder selected is installed, and has been working since 1911, at the Meyer and Charlton Gold Mine in South Africa. Its performance has been discussed in a number of papers and reference will be made to several of these towards the end of the article.

The principal data of the winder are :—

Rock	10,000 lb.
Skip	7,000 lb.
Depth	4,135 ft.
Angle of inclination	27° 10′ to 45
Rope	1¼in.dia.; 2lb. per ft.
Maximum speed	2,000 ft. per min.
Output per hour	86½ tons.

Drums.—Twin cylindrical, 10 ft. dia. ; $\frac{WR^2}{g} = 32,000$

Sheaves.—12 ft. dia. ; $\frac{WR^2}{g} = 5,000$ each

Loading time] .... 45 seconds.

Particulars of the shaft are given in Fig. 12, and the winder is operated on the Ward Leonard system. It is required to find the rating of the winder motor.

Since an output of 86½ tons per hour is required there must be $86\cdot5 \times 2,210 \div 10,000 = 19\cdot4$ trips per hour and the duration of the trip, is, therefore, $3,600 \div 19\cdot4 = 185\cdot6$ seconds. Deducting from this 45 seconds for loading we get 140·6 seconds as the actual winding time per cycle. The equivalent "full-speed value" of the cycle is equal to the total length of the shaft divided by the maximum speed in feet per second $= 4,120 \div \frac{2,000}{60} = 123\cdot6$ seconds, and the total time to be allowed for acceleration and retardation $= 2(140\cdot6 - 123\cdot6) = 34$ seconds. Of this time, 16 seconds will be devoted to acceleration, and the remaining 18 seconds to retardation.

Knowing the nett load, maximum hoisting speed and mean angle of inclination of the shaft, the approximate rating of the motor can be found. Thus,

$$\text{Approximate H.P.} = W \times S \times \sin\theta \times k \div 33,000,$$

wherein W is the nett load in lb. ; S is the maximum speed in feet per minute ; θ is the mean angle of inclination of the shaft,

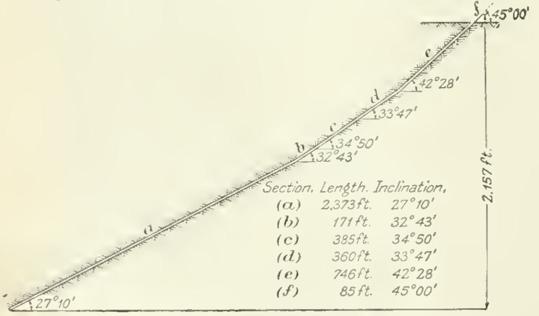

FIG. 12.—PARTICULARS OF INCLINED SHAFT.

and k is a coefficient of which working values for winders of widely different kinds will be given later. We shall assume 1·5 as a probable value of k in this example. The sine of the mean angle is found by dividing the vertical depth of the shaft by the total length of the incline, *i.e.*, $\sin\theta = 2,157 \div 4,120 = 0\cdot52$. Hence,

$$\text{Approximate } H.P. = \frac{10,000 \times 2,000 \times 0\cdot52 \times 1\cdot5}{33,000},$$

$$= 473.$$

and, since the motor is direct-coupled, the speed is that of the drum, namely, $2,000 \div 10\pi = 63\cdot7$ revolutions per minute.

Friction.—The amount to be allowed for friction has to be left to the judgment of the engineer. In this case we have to consider (*a*) shaft friction, (*b*) rolling friction, and (*c*) rope friction.

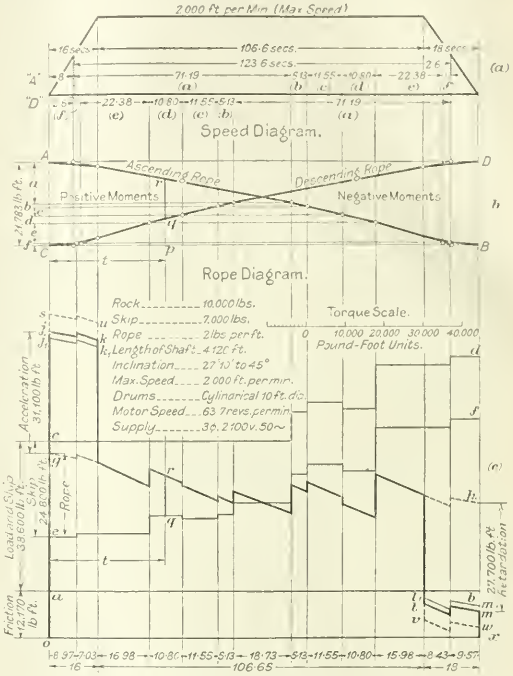

FIG. 13.—SPEED, ROPE AND TORQUE DIAGRAMS.

An allowance of 5 per cent. of the weight of the loaded and unloaded skips will be made for the shaft friction. This corresponds to a moment on the drum shaft of

$$\overset{\text{Total load}}{\{10,000+(2\times7,000)\}} \times \overset{\text{Coef.}}{0\cdot05} \times \overset{\text{Rad.}}{5} = 6,000 \text{ lb.-ft.}$$

For the rolling friction an angle of friction of 2·5 degrees is assumed. The mean angle of inclination of the shaft $= \sin^{-1} 0\cdot52 = 31\cdot5$ degrees; hence the co-efficient $= \cos 31\tfrac{1}{2} \tan 2\tfrac{1}{2} = 0\cdot037$, or 3·7 per cent. The corresponding moment on the drum shaft

$$= \overset{\text{Total load}}{\{10,000+(2\times7,000)\}} \times \overset{\text{Coef.}}{0\cdot037} \times \overset{\text{Rad.}}{5} = 4,440 \text{ lb.-ft.}$$

Irrespective of the positions of the skips there is always a length of rope in the shaft equal to the length of the shaft itself. The weight of rope is, therefore, $4,120 \times 2 = 8,240$ lb. Since the mean angle is 31½ degrees the rope-friction moment will be $8,240 \times \cos. 31\tfrac{1}{2} \times 0\cdot05 \times 5 = 1,730$ lb.-ft. In connection with the rope friction it may be mentioned that the shaft has a curve approaching the catenary; the rope, therefore, will hang fairly freely and the friction will probably be less than the value we have assumed. Nothing is gained by taking this into consideration because the rope friction moment is small in comparison with the total moment, and a slight variation of the small moment makes no appreciable difference to the total moment

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Referring to Fig. 13 (c) the total friction moment, namely, 6,000 + 4,410 + 1,730 = 12,170 lb.-ft. is marked off vertically from o to a convenient scale and is represented by oa. Through a a line ab is drawn parallel to the base ox.

STATIC MOMENTS.

(i.) *Ascending Load and Skip.* The distance moved through during acceleration $\frac{2{,}000}{60} \times \frac{16}{2} = 266{\cdot}7$ ft., and since the length of section (a) of the shaft is 2,373 ft. it follows that 2,373 − 266·7 = 2,106·3 ft. are moved through at a constant speed of 2,000 ft. per min., or 100 ÷ 3 ft. per sec., in 63·19 sec. Similarly, the distance moved through during retardation $= \frac{100}{3} \times \frac{18}{2} = 300$ ft., and retardation begins at a point 300 − 85 = 215 ft. from the end of section (e) of the shaft. In other words the ascending load and skip traverses 746 − 215 = 531 ft. of section (e) at a constant speed of 100 ÷ 3 ft. per sec., and the time required = 15·9 sec. It is convenient to tabulate the moments as shown below.

Determination of Moments due to Ascending Load and Skip.
Load + skip = 10,000 + 7,000 = 17,000 lb. Drum radius = 5 ft.

Section.	Length, ft.	Inclination. θ.	Sin θ.	Moment, $M_a = 5 \times 17{,}000 \times \sin\theta$. lb.-ft.	Time, secs.
a	2,373	27° 10′	0·455	38,600	79·19
b	171	32° 43′	0·540	45,900	5·13
c	385	34° 50′	0·570	48,400	11·55
d	360	33° 47′	0·550	46,700	10·80
e	746	42° 28′	0·680	57,800	24·33
f	85	45° 00′	0·707	60,000	9·57

These moments when plotted to a time base give the stepped line cd in Fig. 13 (c). It should be mentioned that the base used in plotting these moments is ab.

(ii.) *Descending Skip.*—During the accelerating period the descending skip moves through a distance of 266·7 ft. In other words at the end of this period the skip is 266·7 − 85 = 181·7 ft. from the beginning of section (e) of the shaft, and the remaining length of 746 − 181·7 = 561·3 ft. of this section is traversed at constant speed. Since the acceleration is 2·08 ft. per sec. per sec. it follows that the time taken in traversing section (f) = 9·02 sec., and that the corresponding time for section (e) = 23·91 sec.

During the retarding period a distance of 300 ft. is moved through in 18 sec., which brings the descending skip to the bottom of the shaft. Hence the total time taken by this skip to traverse section (a) of the shaft is 18 + (2,373 − 300) ÷ 33·3 = 80·19 sec. The moments are tabulated below:

Determination of Moments due to Descending Skip.
Weight of skip = 7,000 lb. Drum radius = 5 ft.

Section.	Length, ft.	Inclination, θ.	Sin θ.	Moment, $M_a = 5 \times 7{,}000 \times \sin\theta$. lb.-ft.	Time, secs.
f	85	45° 00′	0·707	24,800	9·02
e	746	42° 28′	0·680	23,800	23·91
d	360	33° 47′	0·550	19,220	10·80
c	385	34° 50′	0·570	19,950	11·55
b	171	32° 43′	0·540	18,900	5·13
a	2,373	27° 10′	0·455	15,900	80·19

These negative moments when plotted on the stepped base cd, Fig. 13 (c), give the stepped line ef which represents, at every instant throughout the wind, the resultant torque due to the load and skips plus friction, to the base ox.

(iii.) *Ropes.*—It is convenient to use a graphical method for determining the resultant torque due to the ascending and descending ropes.

Referring to Fig. 14 along a base line ox is marked off a length on to represent the equivalent full-speed time to any convenient scale. This time, which is equal to the total length of the shaft in ft. divided by the maximum winding speed in ft. per sec. = 1,120 ÷ 33·3 = 123·6 sec., is next sub-divided into sections og, gh., ...kn from left to right, the times being taken from the column of the accompanying table marked "Ideal time." The ideal time is simply the time required to coil up at maximum speed a length of rope equal to that of the section. Thus, section (a) of the shaft is 2,373 ft. long and the maximum winding speed is 33·3 ft. per sec., the ideal time, therefore, is 2,373 ÷ 33·3 = 71·19 sec.

Determination of Rope Moments.
Weight of rope = 2 lb. per foot. Drum radius r = 5 ft.

Section.	Length. ft.	Weight, w, lb.	Sin θ.	Moment $m_r = w \cdot r \sin\theta$. lb.-ft.	Ideal time, sec.	Actual time, sec.
a	2,373	4,746	0·455	10,800	71·19	79·19
b	171	342	0·540	923	5·13	5·13
c	385	770	0·570	2,410	11·55	11·55
d	360	720	0·550	1,980	10·80	10·80
e	746	1,492	0·680	5,070	22·38	...
f	85	170	0·707	600	2·55	...
Totals ...	4,120	...	...	21,783	123·60	...

At o a perpendicular is erected and along it is marked off a length om to represent the total rope moment 21,783 lb. ft. Along mo mark-off vertically downwards lengths mn, np . . . so to represent the rope moments in sections (a) to (f) of the shaft.

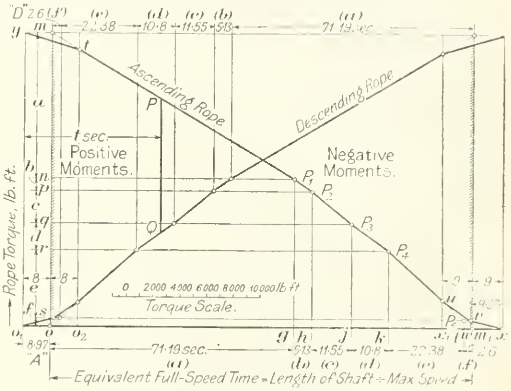

FIG. 14.—ROPE DIAGRAM.

Project n horizontally to meet the vertical projection through g at the point P_1. In like manner obtain points P_2, P_3 . . . P_5. Then the inclined line m . . . m_1, obtained by joining the points m, P_2, ... P_5, m_1, gives the ideal moment line of the ascending rope to the base om_1. Now at the beginning and end of the wind the speed is zero, and full-speed is attained in 16 sec. and stopping is effected in 18 sec.

To allow for this in the case of starting, mark off on the base from right to left the actual time taken in coiling-up a length of rope equal to section (a) of the shaft. This time is 79·19 sec. and is represented by go_1. Through o_1 erect a perpendicular o_1y equal to om. Make oo_2 equal to oo_1, each being equal to half the accelerating period; through o_2 erect a perpendicular o_2t cutting the ideal rope-moment line at t. Join t and y, then the line ytP_1 . . . to the base o_1m_1 represents to scale the variation of moment in coiling-up the ascending rope during the early stages of the wind.

To make the correction for the retarding period proceed in the following manner. Make $m_1x = m_1x_1 = 9$ sec., *i.e.*, equal to half the retarding period. Through x_1 draw a vertical x_1u cutting the ideal rope-moment line P_5m_1 at u. Mark off a length $xw = 9{\cdot}57$ sec. which is the actual time taken to coil up section (f) of rope. Let the vertical through w cut the horizontal through s at the point v. Join uv and vx, then the bent line yt . . . P_2 . . . uvx, to the base ox, represents the variation of torque at the drum shaft in coiling-up the rope on the ascending side.

The descending rope is treated in a similar manner, the ideal times for sections (*a*) to (*f*) being marked-off from right to left as shown at the top of the diagram, and the correction made for starting and stopping.

In Fig. 14 the two rope moments are shown superimposed in such a manner that the resultant moment at any instant is given by the vertical intercept between the two curves. Thus, *t* sec. after the commencement of the wind the resultant moment is represented to scale by *PQ*.

If the reader will take the trouble to master this construction he will be in possession of a useful method of tackling winder problems. We shall have occasion to refer to the subject again in the section devoted to compound shafts.

Fig. 11 has been re-drawn in Fig. 13 (*b*) to the same scale as that used for Fig. 13 (*c*). Remembering that the sign of the rope moment reverses at or near the middle of the wind, the resultant moment due to the load, skips and friction, giving the sloping stepped line *gh* in Fig. 13 (*c*). This line to the base *ox* gives the resultant static torque plus friction at every instant throughout the wind.

Accelerating and Retarding Moments.

Inertia: Irrespective of type or method of control a motor direct-coupled to the drum shaft will have a rating somewhere in the neighbourhood of 475 H.P. A direct-current motor of this output running at 64 revs. per min. will have an armature of about 6 ft. 3 in. diameter and 9·7 tons in weight. The radius of gyration of such an armature will be about 0·75 × 6·25 ÷ 2 = 2·31 ft. and the inertia, therefore, is 9·7 × 2,240 × 2·34² ÷ 32·2 = 3,690, or, say 3,700 in round figures.

The rotor of an induction motor of this rating will weigh about 9·25 tons and will have an inertia of 14,700.

The travelling masses consist of the load, two skips and two lengths of rope, or a total of

Rock		Skips		Ropes	
10,000	+ 2 ×	7,000	+ 2	{2(1,135 + 165)}	= 41,200 lb.

The inertia of the travelling masses is, therefore,

$$41{,}200 \times 5^2 \div 32{\cdot}2 = 32{,}000.$$

Tabulating the inertia of each of the several parts we have

	Direct current.		Three-phase.
Drums, &c.	32,000	......	32,000
Motor armature	3,700	......	14,700
Two sheaves $2 \times 5{,}000 \times \left(\frac{10}{12}\right)^2$	7,000	......	7,000
Travelling parts	32,000	......	32,000
	74,070	......	85,700

Angular velocity of drums $2\pi \times 63{\cdot}7 \div 60$,
= 6·67 radians per second.
Angular acceleration = 6·67 ÷ 16 = 0·417 radian per sec. per sec.
Angular retardation = 6·67 ÷ 18 = 0·371 ,, ,,

and the corresponding moments for the direct-current equipment are

Accelerating moment = 74,700 × 0·417 = 31,100 lb.-ft.
Retarding moment = 74,700 × 0·371 = 27,700 lb.-ft.

In the case of the three-phase motor equipment the moments are

Accelerating moment = 85,700 × 0·417 = 35,800 lb.-ft.
Retarding moment = 85,700 × 0·371 = 31,800 lb.-ft.

Torque Diagrams. By combining the above moments with the static moments we get the total torque diagram *ojk . . . lmxo* Fig. 13 (*c*), for the direct-current hoist and the diagram *osu . . . vwxo* for the three-phase hoist.

It may be mentioned that the ordinates j_1j or j_1s represent the torque required for accelerating the direct-current and three-phase motors respectively.

Winder Motor Rating.—One of the total torque diagrams, namely, that for the Ward Leonard hoist, has been transferred to Fig. 15. Knowing the torque and speed, the corresponding horse-power can be found. Thus

$$\text{H.P.} = \text{Torque} \times \text{angular speed} \div 550,$$

the torque being expressed in lb.-ft. units, and the angular speed in radians per sec.

In this case the angular speed is 6·67 radians per sec., and H.P. = 0·121 × τ. In Fig. 15 the H.P. values are given.

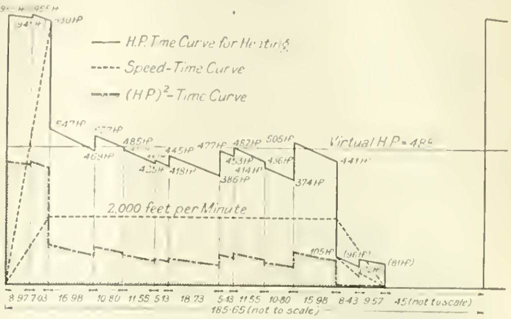

Fig. 15.—H.P. and Heating Diagrams from which Rating of Winder Motor is determined.

From the H.P.-time curve the (H.P.)²-time diagram is obtained. The area *A* of this diagram is determined as also is the equivalent full-speed value T_e of the cycle, and the virtual rating of the motor is given by the expression

$$\text{Virtual H.P.} = \sqrt[2]{(A \div T_e)}.$$

Referring to Fig. 15 the cross-hatched area is equal to $37{\cdot}0 \times 10^6$ H.P.²-sec., and the equivalent full-speed value from equation (1)* = 151·6 sec. Hence

$$\text{Virtual H.P.} = \sqrt[2]{(37{\cdot}0 \times 10^6 \div 151{\cdot}6)}$$
$$= 488.$$

At his leisure the reader can determine the rating of the three-phase motor from the diagram *osu . . . vwxo*, Fig. 13 (*c*). Although the duty is the same in both cases the three-phase motor must, nevertheless, have a virtual rating of 535 H.P. to enable it to dissipate the same heat in a given time and for the same temperature rise as the direct-current motor.

Unbalanced Operation.—The enquiry called for an electrical equipment amply dimensioned to be able to make an occasional unbalanced trip, with one drum unclutched, raising the full load at full speed and then lowering the empty skip.

(*To be continued.*)

Condenser Tube Corrosion.

The Corrosion Research Committee of the Institute of Metals call attention to the important research work they are now carrying out with the object of preventing corrosion generally, and, in particular, that of condenser tubes. This research work has been in progress for 10 years and has been financed firstly by the Institute of Metals alone, and later by the Institute in conjunction with makers of tubes, makers of condensers and the Department of Scientific and Industrial Research. In 1919-20 this Department pointed out that this research was of great interest to the users of tubes and condensers, and that efforts should be made to secure aid for the continuance of the research from the users, as well as from the makers, of tubes and condensers. The Advisory Council state that they will be prepared to recommend for the year ending September 30, 1920, a further grant-in-aid if satisfactory contributions are obtained by the Institute of Metals from the users of tubes and condensers towards the cost of the research. It will be agreed that users of tubes and condensers, among whom electrical engineers must be included, are quite as much concerned with the matter as are those who are already contributing. We are advised that for every £1 contributed by the users the Government will also contribute a like amount. It should be pointed out that the makers are contributing nearly £1,000 per annum, and it is hoped that at least this amount will be forthcoming from the users. Subscriptions should be sent to the Secretary of the Institute of Metals, 36, Victoria-street, London, S.W.1.

We are glad to learn that a gratifying response to the appeal for funds for carrying on this useful work has already been made.

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* The Electrician, March 26th, 1920.

Telephone Repeaters.*

By B. GHERARDI and F. B. JEWETT.

The Repeater Element.

Before attempting any detailed discussion of designs we may well list the operating requirements for a successful repeater element. In so doing we shall not be concerned with the physical principles upon which the device operates, but only with pairs of terminals 1, 2 and 3, 4 of an enclosed and unknown electrical network as illustrated in Fig. 1. If we measure such a hidden element with alternating current we may obtain, for each frequency, several characteristic ratios. Thus, from the ratio of the voltage impressed upon terminals 1, 2 to the resulting current we obtain the impedance of that circuit and similarly for the circuit of terminals 3, 4. We obtain also a mutual impedance by taking the ratio of the voltage produced in the circuit 3, 4 to the current in the circuit 1, 2.

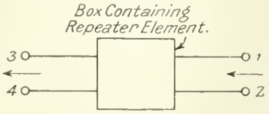

Fig. 1.

Similarly, there may be measured the mutual impedance in the opposite direction. If only one of the mutual impedances is zero, and no voltage is produced on one side when a current is flowing in the other, the device has a "unilateral mutual impedance." Of the repeaters best adapted to telephony all are of this unilateral type.

Essential Requirements.

The requirements are identical whether the device is bilateral or unilateral, but they may be more conveniently stated in terms of the unilateral type, as follows :—

1. The unilateral mutual impedance must be independent of the amplitude of the impressed current, within the range required for telephone transmission, *i.e.*, there must be a linear relation between the output voltage and the input current of the repeater ; the output is then directly proportional to the input. Otherwise one or more harmonics of the impressed alternating voltage will appear in the output.

1 (*a*) The input and output impedances of the element must be similarly independent of the impressed voltage or else distortion will occur.

2. The unilateral mutual impedance must be independent of the frequency of the impressed voltage within the range required for the transmission of the human voice. Otherwise the various overtones in such a complex sinusoidal current as is initiated by a voice will not be faithfully reproduced.

2 (*a*) The input impedance of the element should be independent of the frequency of the impressed voltage ; or should be the same function of the frequency as is the impedance of the telephone line to which it is to be connected. If this condition is not met a distortion, destructive of good quality, may occur

2 (*b*) The output impedance of the element should be similarly independent of the frequency or so related to the impedance of a telephone line that the line may receive without distortion the output of the repeater.

3. The element must give amplification ; *i.e.*, ignoring the energy sources which may be associated with or be parts of the element, the efficiency (measured by the ratio of output and input energies of telephone currents) must be greater than unity. A repeating element adaptable to telephone plant may be expected to give an energy amplification such that telephone currents, which have been attenuated by about 20 miles of standard cable, will be restored to their original values by its action. By transmission through 20 miles of standard cable the current and voltage would be attenuated to about one-eighth, and the energy delivered to the repeater circuit would be only one sixty-fourth of the original energy. Of this only one-half reaches the receiving element, for the rest is dissipated in the bridge. Hence there must be supplied to the line on the output side of the repeater circuit 128 times as much energy as is received. Consideration shows, however, that the output of the repeater itself is equally supplied to the outgoing and the incoming lines. The element must be capable, therefore, of supplying 256 times as much energy as it receives.

4. The sources of energy associated with the element, by which amplification is possible, must have voltages which may safely and conveniently be utilised in the telephone plant.

5. The element must be either insensitive to external electrical disturbances or easily shielded from them so that cross-talk from neighbouring telephone circuits or apparatus may not actuate it.

5 (*a*) Conversely, the element must not be such as to cross-talk into adjacent circuits or apparatus.

6. The element must be constant, reliable and of fair life, and not such as to require frequent attention or laboratory conditions of operation.

7. In size, first cost, cost of energy and of maintenance, the element must conform to the economic conditions of an established plant.

Classification of Repeater Elements.

The classification of repeater elements is as follows : (I.) Electrodynamic repeaters : (*a*) receiver transmitter type ; (*b*) generator type ; (1) direct-current generator ; (2) alternating-current generator ; (3) asynchronous generator. (II.) Electronic repeaters : (*a*) electrostatic ; (*b*) electromagnetic. (III.) Gaseous repeaters : (*a*) electrostatic ; (*b*) electromagnetic ; (*c*) negative resistance.

I. (*a*) The form of telephone repeater which most naturally suggested itself to the early engineers is the simple combination of a receiver and a microphone, and prior to 1903 many unsuccessful attempts were made along this line. The solution was finally reached by one of the Bell engineers, H. E. Shreeve. Previous inventors had combined receivers and transmitters without recognising that the normal functions of their diaphragms were those of sound collecting or emitting members. Shreeve omitted these unnecessary features.

Another difficulty in earlier designs had been the "packing" of the carbon of the microphone which he found to be due to expansion occasioned by the heat liberated in the carbon chamber. In his first successful laboratory model a stretched steel strip was used as a connecting-link between the receiver and the microphone and the microphone was designed so that the expansion of its parts under the influence of heat did not subject the granular carbon between the electrodes to increased pressure. With this form was obtained the first successful test of repeater operation over a telephone line in 1904.

An Early Practical Attempt.

Next, more perfect quality reproduction was secured by making lighter moving parts and increasing the natural frequency of the moving system. The next model, shown in Fig. 2, was commercially operated on a circuit between New York and Chicago, from August, 1904, to February, 1905. In this model the packing of the transmitter element was obviated by the thermostatic action of the vibrating disc, and the natural period of the moving parts was such as to emphasise the important frequencies of the voice. The element was associated with the line by a simple bridge circuit, patented by Edison in 1883. The transmission between New York and Chicago was found to be greatly improved.

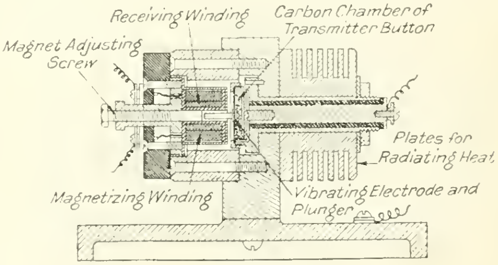

Fig. 2.

In this installation a repeating coil of low mutual inductance was inserted between the line and the receiving element, so as to prevent amplification of the so-called "Morse thump," which occurs when a repeatered line is composited and carries superimposed telegraph signals. This coil was ineffiient for currents of low frequency but relatively efficient for those of voice frequency.

Difficulties arose, however, in the reproduction of this model, and an attempt was, therefore, made to regulate the sensitiveness of the microphone by more positive means. The next model, Fig. 3, had a thermostat in the form of a zinc strip; heated by a coil in series with the microphone. Whenever the current through the microphone increased as the result of incipient packing it served to withdraw the rear electrode.

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* Abstract of a Paper presented at a joint meeting of the American Institute of Electrical Engineers, and the Institute of Radio Engineers.

This repeater, known as No. 1 A, was reasonably satisfactory. But ultimately the natural frequency of the vibrating system was raised still higher, the weight of the moving parts still further reduced and a more sensitive form of regulator adopted.

The Cartridge Repeater.

The latest model, the 3-A repeater, Fig. 4, is of the so-called "cartridge" type and consists of two main parts, the cartridge and the socket. The cartridge contains all the working parts which are liable to become defective and may readily be removed for replacement. It is held in place in the socket by a bayonet catch, and electrical connections are made to its contact posts by springs in the socket. An electro-magnet with differential windings serves to maintain the sensitiveness of the microphone between extremely narrow limits. The initial magnetic field of the receiving element is the resultant field produced by a winding in series with the microphone and an opposing winding in shunt with the microphone. If the steady resistance of the microphone increases, the series winding takes less current and the shunt winding more, or vice versa. These magnetic changes alter the pull on the flexible disc electrode and thus regulate the pressure on the granular carbon.

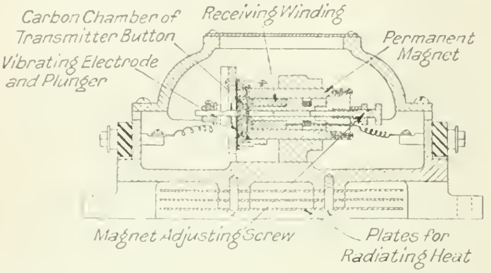
Carbon Chamber of Transmitter Button
Receiving Winding
Permanent Magnet
Vibrating Electrode and Plunger
Magnet Adjusting Screw
Plates for Radiating Heat

Fig. 3.

An inherent defect in this type of instrument is the fact that the sensitiveness falls off rapidly when the input energy is below a certain minimum. As yet no completely satisfactory explanation for this has been advanced. The defect is serious in the operating plant where circuit conditions and volumes of energy at any given point in a circuit fluctuate widely from time to time. Thus, at one moment the repeater in a given circuit may be handling the energy from two persons speaking loudly, using telephones very near the terminals of the circuit, while at the next moment it may be called upon to function with the energy which it receives from telephones connected to long circuits, which in turn connect to the circuit with which it is associated. In these circumstances the energy at the repeater terminals may be many times less than that in the previous case. Yet maximum amplification is much to be desired. The Shreeve type of mechanical repeater is nevertheless serviceable and many units are in commercial service. The amplification is not sufficiently independent either of the amplitude or of the frequency of the input to make them adaptable with best results to use in tandem, but they have been used to advantage on telephone lines the length of which did not require more than three repeater stations.

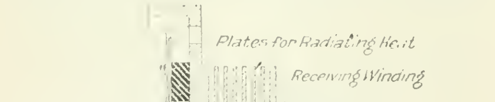
Plates for Radiating Heat
Receiving Winding
Vibrating Electrode and Plunger
Carbon Chamber of Transmitter Button
Magnet Adjusting Screw
Magnetizing and Compensating Windings

Fig. 4.

Theoretical and Experimental Problems.

I. (*b*) The application of the principles involved in direct- and alternating-current generators to the solution of the telephone repeater problem received attention during the decade following 1900. The problem was attacked both theoretically and in experimental design by H. S. Warren, M. I. Pupin, and others. The practice of power engineers suggested two typical methods.

(1) A generator of which the armature should constitute the output circuit of the element and the field winding the input circuit. Variations in the field current will result in corresponding variations of the armature voltage of such a machine. In order to avoid, in the armature, voltage variations due to commutation (which would result in extraneous noises), such a machine must have a frequency of commutation well above that of the highest frequency which is essential to the faithful reproduction of the human voice. Noise currents due to commutation may then be choked out by inductance or filtered out by a periodic structure like an artificial loaded line. Frequencies of 2,500 cycles per second are required for good quality of telephone speech, so that for any practical design of armature and commutation the peripheral speed must approach the allowable mechanical limit.

Various unipolar designs were therefore considered in which no commutation is required. In such machines, where the field current is only of telephonic magnitude, the flux is very small and the E.M.F. obtainable at any mechanically allowable speed of rotation much below that requisite for a successful telephone repeater. In addition, eddy current and hysteresis losses are high because of the frequencies involved. The input impedance, being that of an electromagnet, is not independent of the frequency, as is desired, but discriminates against the higher frequencies of the voice wave. Even if it were possible to build and operate such high-speed generators as repeaters of feeble currents, the type is deficient in many of the characteristics required of a successful commercial repeater. Now that simpler and practically perfect repeaters are available, it is doubtful whether the possibilities in this type of apparatus will ever be worked out.

(2) The practical difficulties of eddy currents and hysteresis losses, of limiting speeds and of small input, also prevented the development of a successful repeater along the lines followed in the power engineering of alternating currents.

(3) In 1900, Joseph Lyons disclosed to us * his invention, a telephone repeater upon the principle developed and patented in power engineering by Hutin and Leblanc. The principle is that of an induction motor driven above synchronism by a local source of mechanical energy. The conditions under which such a device may serve to supply energy to a transmission line, across which it is connected, are familiar. It was Lyons' idea that the stator should be bridged across a telephone line and, through the interaction of the received current with that induced in the short circuited rotor, should supply to the line additional energy of the same wave form as it received. In order, however, to supply energy at any telephone frequency the speed of the rotor must be at least as large as the quotient of the given frequency and the number of pairs of poles in the stator. Thus, for a 12-pole stator a frequency of 2,400 cycles per second would require a speed of 400 revs. per sec. Not only is the speed too high for practical operation but the machine would fail to meet the second requirement for a repeater. The amplification for each frequency would depend upon the negative slip at that frequency and thus the lower frequencies of the voice current would receive more amplification than the higher ones.

That the mechanical limitations of speed, clearance, thickness of lamination, and the other factors familiar to designers of dynamo equipment should have prevented the development of such a generator is understandable. What was required was a generator which could operate on about one-half of a milliampere of field current. To give an energy amplification of 256 times, its field losses must be less than 1 per cent. of the output. The value of one-half of a milliampere is the effective value of a complex wave form, all the sinusoidal components of which must appear in the output with equal amplification.

Electronic Repeaters.

II. Electronic repeaters are those in which the moving parts are discrete electrons whose motions are unimpeded by molecular matter. Such devices, therefore, require a vacuum sufficiently high that the motions may be characteristic of free electrons. There must also be a means of supplying free electrons, that is of dislodging them from molecular matter of which they form constituents. The satisfactory method of accomplishing this is to "boil them out" of a piece of metal or metal oxide. Our present electronic repeaters are therefore "thermionic" devices.

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* The American Telegraph & Telephone Company, Ltd.

The voltages involved in the detection of radio signals are much smaller than those met with in telephony, so that no serious inconvenience arises from the presence of residual gas. But in dealing with the very much larger energies employed with telephonic repeaters one must insure the removal to a high degree of all gaseous material in the tube, including that occluded in the walls of the tube or the enclosed metallic parts. All the advantages of a pure electron discharge are then retained, even for the higher voltages and currents dealt with in a telephone repeater.

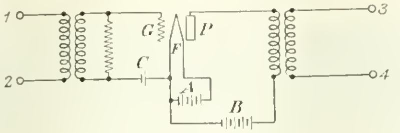

Fig. 5.

Much work has been done by the engineers of the Bell System in producing suitable forms and proportions of tubes to give the best results with the various types of repeater circuits; and in devising a type of filament which will insure a maximum of life and a minimum of power consumption for the amplifying tube and at the same time insure a uniform operating characteristic throughout the life of the tube. It is now possible to produce in quantity tubes of exactly the same characteristics, a feature of the utmost importance in telephone repeater operation, but of minor importance in radio work. Non-uniformity in the tubes would involve the readjustment of apparatus each time it might become necessary to replace a worn-out or damaged tube.

The net result of these researches has been our ability to design and construct tubes adapted to any purpose of communication. In the final form of vacuum tube used as a telephone repeater we obtain a characteristic relation between input voltage and output current which is free from distortion as far as we can recognise such effects. This is obtained partly by the design of the tube and partly by the proper adaption to it of its associated circuit.

Firstly, we arrange that the repeater shall have a constant and finite input impedance by bridging between grid and filament a high resistance. To this resistance current is supplied by a step-up transformer as indicated in Fig. 5. The voltage effective in the grid-filament circuit is then the drop across the resistance. Secondly, we generally arrange that the grid shall not be positive at any time in the cycle of the impressed voltage. This is accomplished by inserting a battery, *C*, in the grid circuit. In this way the tube acts as a device for amplifying the impressed voltage and introduces no distortion due to the unilateral conductivity of the grid circuit.

The characteristic relation between grid voltage and plate current is not that of a perfect repeater, since there is not a linear relation between input voltage and output current. This relation assumes no external resistance in the battery circuit, the voltages being those effective between plate and filament. If, however, there is external resistance in the plate circuit, then the effective voltage between the plate and the filament will be less than that of the battery by the amount of the *IR* drop in the external circuit. An increase in the grid voltage will not, then, produce as large an increase in plate current because such an increase as it would if the plate voltage was constant is partially neutralised by the decrease in the effective plate voltage which the *IR* drop occasions. The result is that by properly proportioning the external resistance of the plate-filament circuit we may obtain a characteristic relation between grid voltage and plate current which is essentially linear as shown by the full line curve of Fig. 6.

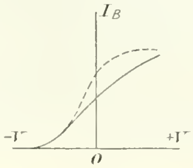

Fig. 6.

(*To be continued.*)

The Largest Rolling Mill in the World.

A 20,500 h.p. Electrically Driven British Installation.

The application of electricity to driving iron and steel rolling mills is of comparatively recent date. Electric motors were first employed for driving auxiliary machinery in and about the works and it was not until some time afterwards that successful attempts were made to use the electric motor for driving the mill itself. At first greater progress was made on the Continent than in this country in this direction, but although we started late we have been gradually catching up; and the interesting "all-electric" installation which has recently been erected and set to work at Messrs. Dorman & Long's new Warrenby Mills, near Redcar, places us in the leading position both as regards size and up-to-dateness of lay-out. This mill is a 42-in. plate mill of the reversing type. It consists of a stand of rolls—one roughing and one finishing, each roll being 3 ft. 6 in. in diameter and 9 ft. 6 in. long. The mill can deal with slabs up to 7 ft. by 4 ft. 6 in. by 1 ft. 6 in., weighing 10 tons. These slabs are rolled into plates varying from ⅜ in. thick upwards and reaching 9 ft. wide by 100 ft. long. Plates of this thickness are turned out at the rate of 60 tons per hour for two hours, and operations for the remainder of the shift are continued at the rate of 30 tons per hour. Having given all these statistics, it is, perhaps, hardly necessary to add that this is the largest rolling mill in the world.

Before giving a description of the electrical equipment of the mill, a few words may be said about the uses to which electricity in the works, and this may best be done by following the progress of the material through the works from the first to the final operation. The Warrenby Works are very extensive, and lie on either side of the North Eastern Railway, between Middlesbrough and Redcar. A special station has been erected on this railway for the convenience of the officials and workmen and adequate siding accommodation is also provided.

The electrical energy necessary for driving the works is obtained from two power stations, one in the iron works and one in the steel works, and also from the mains of the Cleveland & Durham Electric Power Company, Ltd. The first of these power stations is erected at the blast furnace department, and contains one 1,000 kw and one 750 kw. mixed pressure turbo-alternators both by the British Thomson-Houston Company. The other station is at the rolling mills, and contains one 3,000 kw. B.T.-H. mixed-pressure turbo-alternator and one 2,000 kw. Howden-G.E.C. mixed-pressure turbo-alternator. These two stations work in parallel, and also in parallel with the network of the Cleveland & Durham Electric Power Company. The energy is generated at 2,750 volts three phase, and at a frequency of 40. The current obtained from the power company is also at a frequency of 40 and a pressure of 11,000 volts, which is transformed down in a special sub-station to the works' pressure of 2,750 volts.

Three-phase transformers are also installed at each station, stepping down the high-tension current to 440 volts, at which pressure most of the auxiliary motors throughout the works are operated.

The power station also contains a 500 kw. Bruce-Peebles-La Cour converter, a 150 kw. B.T.-H. motor-generator set, and a 75 kw. Lancashire dynamo set. These machines supply direct current at 220 volts for lighting and other purposes.

Current required for the village of Dormanstown, where houses are in the course of erection by the firm for the accommodation of the workpeople, is transmitted at 2,750 volts and transformed down to a suitable voltage for lighting and other purposes.

The switchgear in the steel works station is of Messrs. Reyrolle & Company's well known armoured design. Fig. 1 illustrates the 20,000-volt board which consists of six panels, two of which are fitted with apparatus for Merz-Price patent protection for the 3,000-k.v.a. transformers. The remaining panels control three-phase feeders and are equipped with Merz-Hunter split conductor protection apparatus combined with ordinary overload on three phases. The whole of the fittings of this gear, *i.e.*, the transformers, 'bus-bars and all cable connections are filled in solid with compound having very high insulating properties, thus enabling the gear to be of a compact design. All switches are fitted with boiler plate tanks in accordance with Messrs. Reyrolle's standard practice, and are direct operated and removable from the front of the board. Below the high-tension switchgear gallery the 3,000-volt gear (Fig. 2) is erected, and consists of a board made up of "B" class panels, which are remote mechanically operated by means of a hand-wheel on a black enamelled slate panel, through which the connecting spindle passes to the operating mechanism on the switchgear. A special feature in connection with the two generator panels is the automatic self-balance generator protective apparatus. This is a system of balanced protection designed to combine the main benefits which are obtainable from both Merz-Price and split conductor protection. The benefits of the split conductor system are mainly due to the fact that the connections from each end of a phase winding pass through a ring type current transformer having one secondary winding, so that on each protection transformer there is a true balance of currents, and not as in "Merz-Price" a balance between two separate and distinct transformers, each having its own magnetic circuit. In the self-balancing type of protection, therefore, connections from both ends of the generator winding which is to be protected are passed through a common ring core to form the current transformer. The secondary of the transformer is then connected to a relay which operates the trip coil of the main switch. A simplified diagram, Fig. 3, shows the connections of Form "C" of this protection for star connected plant, and in this particular instance single core cables and a neutral cable are run to and from the machines.

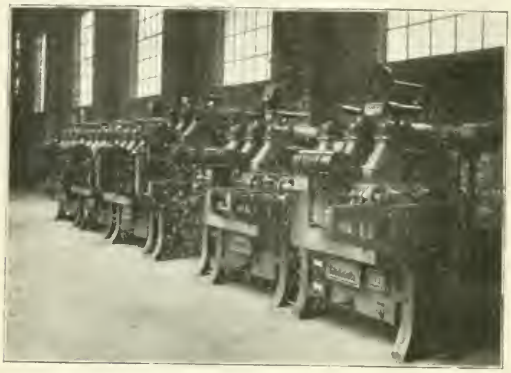

Fig. 1.—View of the 20,000 volt Board.

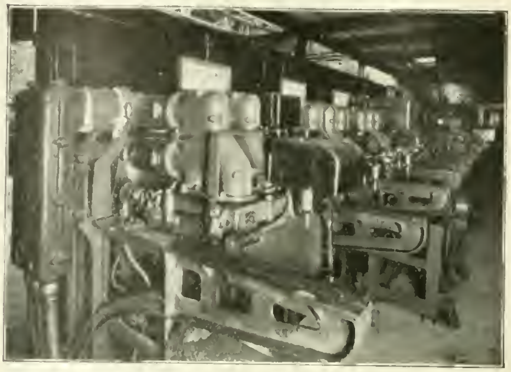

Fig. 2.—The Back of the 3,000 volt Gear.

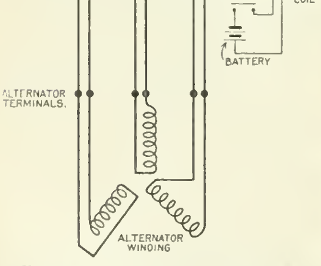

Fig. 3.—Diagram of the Generator Protective Apparatus.

All instruments and protective gear apparatus are fitted on the front of the control board, but the switch operating mechanism is all embodied on the gear itself at the back of the control board (see Fig. 2). The general construction of this low-tension gear is similar to that of the 20,000 volt gear described above.

It may be added that magnets for lifting and transporting purposes are extensively used throughout the works. The current for operating these is obtained from two special 150 kw. G.E.C. motor-generator sets, converting the 3,000-volt alternating-current supply to direct current at 105 volts. The magnet circuits are controlled from a special switchboard in the generating station, which was supplied by the Metropolitan-Vickers Electrical Company, Ltd.

The energy obtained from the power company is passed through two banks of transformers, each with a capacity of 1,500 kw., whence the supply goes to the ordinary 3,000-volt board.

Turning now to the progress of the metal through the works, the molten metal for the manufacture of steel is brought over from the ironworks by a special railway, and discharged by an Isles ladle crane into the mixers, whence, after suitable treatment, it is discharged into a ladle in the tapping bay. This ladle during pouring is held by one of three 120-ton cranes, each of which has one main hoist and two auxiliary hoists, so that the ladle can be turned in any direction. These ladles discharge the molten steel

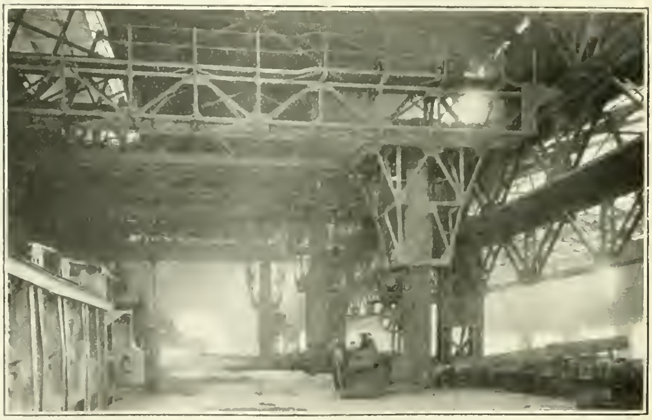

Fig. 4. View of Charging Machine.

into ingot moulds carried on special travelling bogies, and when pouring is completed they are drawn off into the stripper bay by steam locomotives. When the contents are sufficiently cooled down the ingot casing is removed by means of a Wellman overhead stripping machine. The ingot then passes to the cogging mill bay, where it is reheated and is then charged into a soaking pit by a special electrically-driven ingot crane, which is fitted with special grips so that the ingot itself can be securely held. After this heating is completed the ingot passes to the cogging mill which is steam driven, and therefore need not be further referred to here. The chargers for cold material are of the Babcock & Wilcox type, an illustration of one of these machines being shown in Fig. 4. They have a span of 57 ft. from the centres of the rails and a normal load of 3½ tons. The charging boxes are 7 ft. long, and the speeds of operation at full loads are as follows: Hoisting harmonic rocking motion, eight complete strokes per minute; cross traverse, 125 ft. per minute; longitudinal travelling 250 ft. per minute; and bar turning, 10 revs. per min. Control is effected from a special cabin at the base of the machine as can be clearly seen in the photograph (Fig. 4).

The auxiliary gear in connection with this mill is, however, driven electrically by 75 h.p. G.E.C. motors of rather interesting design, in that the motor frame is split through the centre so that both the rotor and stator windings can be lifted out without any interference with the bottom half of the motor. An 8 in. extension shaft is fitted on each end of the shaft of these motors in order that the motors may be interchangeable in case of breakdown, an important point in a place like a rolling mill, where it is essential that an operation once begun should be carried on to the finish. In the cogging mill these motors drive the roller gear, which moves the ingots to and from the mill. The screw down gear in connection with the mill is driven by 75 h.p. Lancashire Dynamo Company's motors. The effect of passing the ingot through the cogging mill is to reduce it to the form of slabs, which are then cut into convenient sized pieces in streams, and are picked up by two Wellman charging machines and heated in a special slab heating furnace. They then pass to the rolling mill proper, some further details of whose electrical equipment which was supplied by the British Thomson-Houston Company is now given.

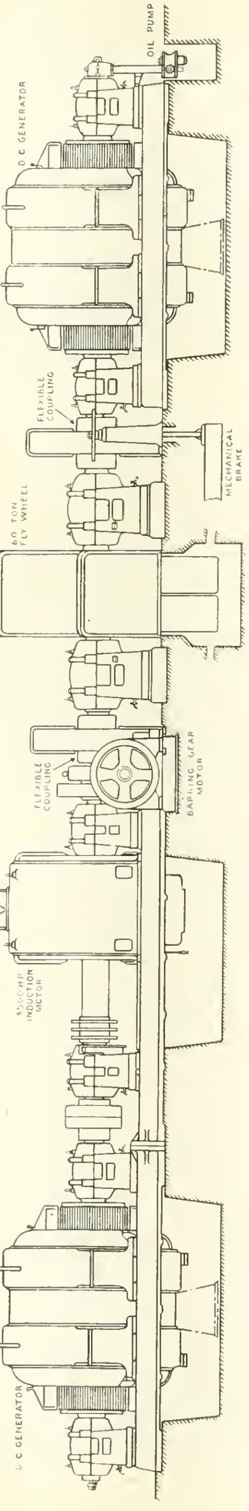

Fig. 5.—Arrangement of Flywheel Motor-Generator Set.

The electrical equipment of the mill consists of the following main parts: (1) High-tension truck type alternating current switchgear; (2) flywheel motor-generator set and auxiliaries; (3) exciter set and auxiliaries; (4) direct-current switchgear; (5) field controller and resistances; (6) mill motor and auxiliaries; (7) contactor type slip regulating and starting panel for the flywheel motor-generator set.

The high-tension alternating-current switchgear comprises five trucks or cubicles equipped as follows: (1) Bus section equipment, (2) incoming truck with cable boxes and isolating switches; (3) 3,500 h.p. truck for supplying the induction motor of the flywheel motor-generator set (this truck contains an 800 ampere triple-pole oil-switch with charging resistances, overload and low-voltage release, an ammeter, voltmeter and three-phase integrating watt-hour meter); (4) 200 h.p. truck supplying the induction motor which drives the exciter set; and (5) the truck shell for housing the transformers for the slip regulating panel.

Flywheel Motor Generator Set.

The arrangement of the flywheel motor-generator is shown in Fig. 5. The set comprises a slip-ring type 3,500 h.p., 600 revs. per min., 2,750-volt, 40 cycle, three-phase induction motor driving two double unit generators, which supply current to the mill motor at 1,600 volts, and a 60-ton flywheel.

The flywheel is composed of two separate 30-ton wheels mounted side by side on the same shaft. Each of the wheels is built up in three parts consisting of a central disc and two rims which are spiggotted and riveted to the central disc. This construction enables the weight to be mainly concentrated in the rim without introducing any unknown casting or shrinkage strains which are always liable to occur in a wheel which is cast in one piece. The stored energy in the flywheel when running at 600 revs. per min. is 46,900 ft.-tons, and the available energy which the flywheel is capable of giving out while decreasing in speed from 600 to 500 revs. per min. is approximately 85,000 h.p. seconds.

The connection between the flywheel and each portion of the motor-generator set is made through a special spring type flexible coupling, so that in the event of the foundations settling—as may readily occur in the case of a long set with such heavy weights—no trouble will be caused by the alteration in alinement.

The flywheel bearings are force lubricated and water-cooled so as to ensure a conservative running temperature. A mechanical brake with water-cooled shoes is fitted, which enables the flywheel motor-generator set to be brought from full speed to rest, in rather less than 10 minutes. The adoption of mechanical braking, although somewhat expensive to instal, provides a ready and reliable means of shutting down comparatively quickly in case of an emergency.

A motor driven barring gear is installed approximately at the centre of the set, for turning the set round slowly, so as to ensure that an oil film is formed on the bearings before the driving motor is switched on. It is also used for turning round the set for inspection and other purposes. The barring gear automatically trips out of mesh, when the driving motor over-runs the gear.

Both the generators and the induction motor are enclosed and arranged for ventilation with filtered air: suitable wet air filters and fans being supplied for this purpose. This precaution prevents the windings being choked up with dust, which is usually present in the atmosphere of a steel mill, and which would otherwise be carried into the machines with the ventilating air. While the cost of the equipment is necessarily increased by adopting this method of ventilation, it is considered that the additional outlay will be well repaid, owing to the small amount of cleaning rendered necessary, and also by the increased insurance against breakdown.

(To be concluded.)

A scientific Paper recently issued by the Bureau of Standards deals with "A New Form of Vibration Galvanometer." This has a sensitivity higher than other forms of the moving-iron type, but less than that of the most sensitive forms of the moving-coil type. It consists essentially of a fine steel wire mounted on one pole of a permanent magnet, and so arranged that the free end of the wire may vibrate between the poles of an electromagnet through which the current to be detected passes.

Thermionic Vacuum Tube as Detector, Amplifier and Generator of Electrical Oscillations.*

By W. H. ECCLES.

Any kind of matter that can be heated above incandescence without destruction emits electrons, that is, corpuscules of negative electricity. In consequence, if a hot and cold electrode have suitable E.M.F. applied between them negative electricity is propelled across the space and constitutes a thermionic current. If air is present the phenomena are complicated, but in a vacuum they are relatively simple. Our knowledge of the phenomena is largely owing to the work of O. W. Richardson and Irving Langmuir. In extremely high vacua the whole current consists of electrons leaving the hot cathode and entering the substance of the cold anode. If the cold electrode be made negative and the hot one positive the electrons will not leave the hot conductor and, therefore, there is no current. A vacuous tube with a hot and a cold electrode therefore acts as a rectifier; such a tube is called a diode. This tube was introduced into wireless telegraphy by Prof. Fleming 15 years ago and was known as the Fleming valve. Alternating current is rectified with great perfection by such a tube.

THE SPACE CHARGE.

In their flight from the hot cathode to the cold anode the electrons fill the space between the electrodes and constitute the space charge. The electric field which they produce tends to repel those electrons just emerging from the cathode back into that conductor. They produce in effect what may be termed a back E.M.F. which has to be overcome by the battery applied between anode and cathode. The main result is that the current is not proportional to the potential difference, but instead varies as the three halves power of the P.D. The number of electrons emitted per second from a hot conductor depends greatly on the temperature. The theory of the emission is analogous to that of evaporation, and agrees with the experimental results. For example, for tungsten, if the emission at 2,100° Kelvin is 5 units, at 2,220° it will be 25, at 2,300° 40, at 2,400° 110, increasing the more rapidly the hotter the conductor. However, not all the electrons can be taken to the anode by a small E.M.F., in fact for each voltage there is a temperature beyond which it is useless to go on account of the fact that the space charge when large enough makes the electric field near the cathode zero, and no more electrons can leave the cathode until the applied voltage is increased. It is easy to increase the applied P.D. up to such a value that all the electrons being emitted from the filament are carried across to the anode immediately, and thereafter no increase of P.D. can produce a greater current; this state is called the saturated condition for that temperature of the cathode.

This phenomenon has had applications as a so-called limiting device, which is such a device that however large be the voltage accidentally applied the current passing through a chain of apparatus protected by the limiting device cannot exceed a pre-determined value.

The best known form of diode in this country has a straight filament as cathode and a co-axial metal cylinder as anode. Of necessity the ends of the filament project beyond the cylinder and are cooler than the central parts, and this leads to different portions of the filament reaching the saturation value in turn as the voltage between the cylinder and filament is gradually increased. The curve connecting current and applied P.D. departs therefore from the three halves power law and becomes nearly straight over a considerable range. One convenient result of this is that the tube behaves as if it had a constant internal back E.M.F. and a constant internal resistance over that range. This greatly facilitates calculations.

THE ADDITION OF A THIRD ELECTRODE, OR GRID.

The thing which has brought the thermionic valve into prominence is, above all, the addition of a third electrode; such an instrument may be called for short a triode. In tubes of cylindrical type the third electrode is usually a co axial helix between the filament and the cylinder.

The third electrode was first introduced into the tube by L. de Forest. Perhaps the aim of early experimenters with a third electrode was to deflect the electrons sideways during their flight, and so affect the current. As a fact it acts by annulling the electric field of the space charge, especially near the cathode, and its influence on the electrons is of the nature of an acceleration or a retardation in their line of motion; an acceleration if the third electrode is made positive, a retardation if it is made negative. The third electrode, or grid as it is called, is made of small surface so as not to absorb many electrons it may take the form of a helix of wire, a piece of metal netting or a perforated cylinder, or any other form that will allow electrons to pass through it on their way from the filament to the anode. Because it is nearer the cathode than is the anode a positive P.D. of, say, one volt, has greater influence on the space charge than an equal P.D. applied to the anode and therefore, as regards annulling the back E.M.F. of the space charge, one volt on the grid is worth several on the anode. In many small tubes it has values like 10 and 20 It can be measured crudely, as indicated in Fig. 1 by inserting one cell in the grid circuit and finding how many must, in consequence, be removed from the anode circuit in order to keep the current constant but it is more accurately and quickly measured by the slide wire arrangement of Fig. 2 wherein the sliding contact is adjusted to keep the current constant whether the key is up or down. This feat of transferring the grid voltage to the anode circuit after multiplication may be accomplished without the flow of appreciable current in the grid circuit, so that the current magnification is much greater than the voltage magnification and the ratio of the power liberated in the anode circuit to that applied in the grid circuit is larger still. It is to these facts that the remarkable amplifying properties of the triode are due.

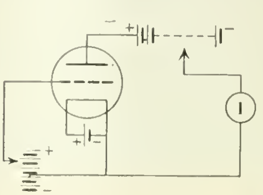

FIG. 1. ROUGH MEASUREMENT OF VOLTAGE FACTOR.

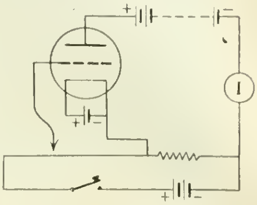

FIG. 2.—SLIDE-WIRE MEASUREMENT OF VOLTAGE FACTOR.

CASCADE AMPLIFIER.

When several tubes are assembled in tandem so that each magnifies the electrical effects passed on from its predecessors we obtain what is called a cascade amplifier. These cascade arrangements are called "two-step," "three-step" and "many-step" amplifiers according to the number of tubes employed, and many designs are in use. In classifying them it is found well to consider a single tube first and to observe that there are two extreme methods of using such a tube for magnifying small E.M.F.'s or currents. The first is the constant current method and is shown in Fig. 3. The second is the constant P.D. method, and is shown in Fig. 4.

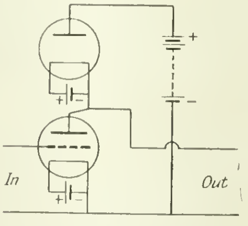

FIG. 3.—AMPLIFIER WITH CONSTANT ANODE CURRENT.

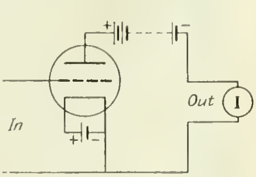

FIG. 4. AMPLIFICATION WITH CONSTANT APPLIED ANODE VOLTAGE.

In Fig. 3 the constant current is ensured by using in the anode circuit a saturated diode as a limiting device. In this case the indicating instrument on the output side must be of a kind that takes a current which is small relative to the current passing through the tubes shown. If the frequency of the E.M.F. applied to the anode is of audible order or higher a choking coil may be used instead of the saturated diode. In Fig. 4 the indicating instrument should be of low resistance and able to pass the whole current, or for sensitiveness might be a differential galvanometer.

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* Abstract of two lectures delivered before the Royal Institution.

In general these extreme types are departed from in the construction of amplifiers and cascade connections are formed by the use of resistances, condensers, or transformers in the manners indicated in Fig. 5 and Fig. 6.

Various experimental illustrations were given in the lecture of the amplifying properties of single tubes and cascade amplifiers. One of these consisted in passing the discharge of a radium clock into the anode circuit of a cascade amplifier and thus making the striking of the clock audible to the audience. The radium clock, it may be explained, consists of a pair of insulated metal leaves in a tube containing a little radium. When they diverge in consequence of an accumulation of electricity upon them they touch stationary side electrodes and are discharged, to begin the process of accumulation again.

Applications of Triode Tubes.

In the second lecture various applications of the properties of the triode tubes were discussed. By the expenditure of a very small amount of power in the grid circuit it is possible to liberate much greater power in the anode circuit, and therefore the grid can be utilised for controlling electrical or mechanical movements by means of larger changes in the plate circuit. For instance a pendulum can be sustained in oscillation by a magnet in the anode circuit when the impulses it receives are timed by another pendulum of the same natural period inducing minute currents in a winding in the grid circuit.

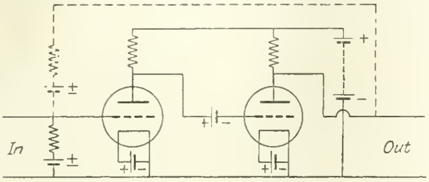


Fig. 5.—Resistance Cascade Amplifier.
(The dotted line shows a retro-active connection.)

A small motor was shown consisting of an ebonite disc with iron teeth mounted on a spindle so that the teeth pass in front of two electromagnets, one of which is in the grid circuit and the other in the plate circuit. A tooth passing the grid electromagnet stimulates a flow of current in the anode electromagnet, and this pulls round the next tooth. Speeds of rotation up to 100 per second have been obtained with this simple mechanism.

This automatic regulation of anode current by grid E M F. was also illustrated by the maintenance of a tuning fork, one prong of which induced E.M.F. in the grid circuit and the other of which was pulled or pushed by an electromagnet in the plate circuit.

Electrical Oscillations.

Electrical oscillations as well as mechanical can be maintained by the aid of triode tubes. All that is necessary is to arrange that the sustained oscillating circuit acts upon the grid and is acted upon by the fluctuating anode current concordantly.

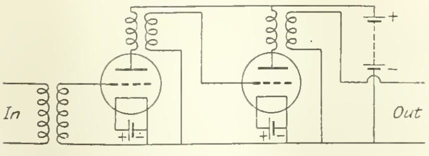


Fig. 6.—Transformer Cascade Amplifier.

The simple circuit shown in Fig. 7 was demonstrated, and by aid of a tuned circuit connected to a crystal detector and galvanometer was shown to be traversed by oscillatory current. But the most striking way of detecting the existence of oscillations in one set of apparatus is to bring near it another set of apparatus oscillating at nearly the same frequency. What happens then is analogous to the well-known facts on relative motion. For instance, if two trains are travelling on parallel rails in the same direction at nearly equal speeds it is possible for an observer in one train to read the labels on the windows of the other; but if the difference of speed increases reading becomes more difficult, and is impossible if one train is stationary and the other moving quickly. In the same way in order to examine an oscillatory motion in one apparatus we might make a second oscillate at nearly the same frequency, the relative oscillation in this case having a frequency equal to the difference of the respective frequencies. The detection of an electrical oscillation by observing its motion relative to an oscillation of nearly equal frequency is called the beat method or the heterodyne method; but besides this bringing together of the two oscillations it is necessary to provide that the relative oscillation, which is of frequency equal to the difference of the respective high frequencies, shall be rectified so that pulses of current of the difference frequency can be sent through a telephone receiver and made audible. When the sets on the table were oscillating at the rate of 500,000 and 500,100 per second, and when one set was arranged as a rectifier as shown in Fig. 8 the beat note was made audible to the audience by passing the pulsating rectified current into an amplifier and, after this magnification, through a telephone.

Cumulative Rectification.

The circuit of Fig. 8 rectifies on account of the fact that when the grid is positive some electrons land on it and when it is negative none can do so. The condenser accumulates these electrons with the result that the grid becomes so negative that the anode current is greatly diminished. The resistance in parallel with the condenser is called a grid leak, and is placed there to provide for the escape of the accumulated electricity gradually. Without it the grid would remain permanently negative and the anode current permanently zero. Starting with the difference of the frequencies as high as 10,000 per second and then altering the condenser in the circuit of higher frequency so as to reduce the difference, an adjustment is shortly reached at which the difference is made audible as a high note. Continuing to increase the capacity of the condenser the note descends in pitch until the difference of the high frequencies is about 30 per second and ceases to be audible. Continuing to increase the capacity the point of exact equality of the high frequencies is passed, and, the circuit undergoing change attains a frequency 30 vibrations per second lower than the other, when we again get the heterodyne note. Continuing to move the condenser in the same sense the difference of the frequencies now increases and the pitch ascends through many octaves until at last too high for the telephone to chronicle. It is noticeable that the beat note is loudest at medium frequencies on both sides of the in-tune adjustment. This is chiefly on account of the idiosyncrasies of the telephone diaphragm but partly on account of variation in the sensitiveness of the ear.

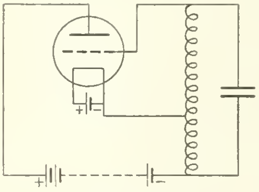


Fig. 7.—Triode Oscillation Set.

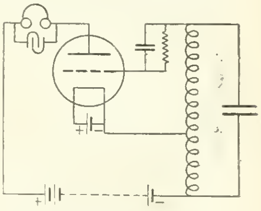


Fig. 8.—Oscillator with Cumulative Rectification for Beat Reception.

Applications of the Beat Principle.

In wireless telegraphy signalling can be carried on by making relatively slight changes in the frequency of a transmitting station when the reception is carried out by the heterodyne method, for the changes in frequency when combined with oscillations of steady frequency at the receiving station produce changes of the note in the telephones of the receiving operator sufficient to mark the Morse signs. The changes of frequency may be made by altering the capacity or the inductance of the apparatus at the sending station. This may be demonstrated with the present apparatus by moving the hand to and from a condenser or by opening and closing a loop of wire in the neighbourhood of the coil Change of filament current was shown also to produce changes in the frequency of the apparatus used as the sending station.

Another piece of apparatus was made in precisely the same manner as the former pair of oscillating circuits but with smaller coils and with smaller condensers. As a consequence, this was much more sensitive to changes in the value of the capacity or the inductance or of other factors. Such a pair of circuits can be used as an induction balance; for a piece of metal, especially if in the shape of a closed ring of wire, if held near one of the coils, alters the frequency of one set and therefore the pitch of the heterodyne note. It is possible to distinguish between a piece of iron and a piece of copper of the same size and shape, for the induced currents in the piece of metal under test are responsible for the alteration of the effective inductance and these currents depend upon the effective resistance of the metal. The arrangement is so sensitive that it easily perceives the conductivity of the burning gas of a Bunsen flame. It is similarly sensitive regarding changes of the capacity of the condenser in either set. For example, the approach of a piece of ebonite towards the plates of a condenser, or the insertion of a small piece of paper between such plates, produces a great change in the note. Again, the pouring of a little ether vapour into a condenser and the blowing of it out produces a change in the note.

Finally it was shown that if a gold leaf electroscope with two side plates be connected, in parallel to one of the condensers, the divergence of the leaves is sufficient alteration to the electrical capacity of the arrangement to produce a distinct change in the beat note.

Coal Conservation in the United Kingdom.

In his James Forrest lecture at the Institution of Civil Engineers on April 20, Sir Dugald Clerk criticised somewhat strongly some of the assumptions upon which the Coal Conservation Sub-Committee, under the chairmanship of Lord Haldane, based their conclusions.

This report is regarded by many leading central station engineers as picturing an ideal state of affairs rather than one likely to arise in actual fact. Sir Dugald Clerk, however, criticised it on other grounds.

According to the Committee, 80 million tons of coal were consumed in this country in 1917 for power production, including railways; and only 25 million tons would be required if the whole of the existing steam engines in separate factories, and the steam locomotives on railways, were replaced by a great general system of electrical generation and distribution. To this end many existing stations were to be purchased by the State, and large turbo-electric stations established at about 16 centres; their mains being linked up so as to provide a network capable of supplying our whole power needs by electric motors. By this means it was expected to save 55 million tons of coal on power only. Sir Dugald Clerk doubted if these sweeping conclusions were justified, since the accuracy of the data presented was questioned by many competent electrical and motive power engineers.

The Four Bases of the Report.

The report assumed an approximate knowledge of four values (1) the amount of coal used in the United Kingdom for the power production only; (2) the amount of mechanical or electrical energy produced from this coal and used in driving workshops, mills, factories electrical generation and railways by steam engines, reciprocating and turbine; (3) the present consumption of coal per brake-horse-power hour (calculated from (1) and (2)); (4) a possible reduction of total consumption of coal by proposed super stations.

The lecturer discussed these four points in detail. A figure of 5 lb. of coal per brake-horse-power was adopted in the report as the average fuel consumption. When the Committee reported in April, 1917, however, no adequate data existed on this point, but the establishment of the Coal Controller's Department led to a thorough examination of the output of the electricity generating stations of the country. Mr. D. Wilson, the technical adviser to the Coal Controller, had shown that for the year ending March 31, 1918, there were 421 generating stations using coal, which generated 4,674 million units on an average consumption of 3·47 lb. of coal per B.O.T. unit, or 2·59 lb. per electrical horse-power hour. This gave accurate knowledge of 10 per cent. of the whole power of the country. Other figures published of the textile, iron, steel and metal industries, and colliery boiler plants, showed a much lower consumption of coal than that adopted by the Committee. It was only when small high-pressure non-condensing engines were used to drive small factories and separate machines that so much as 5 lb. of coal per brake-horse-power were required. Mr. Roger T. Smith had stated that if all the railways of the country were to be electrified 7 to 8 million tons of coal per annum might be saved; other electrical engineers were less hopeful. Even on this assumption Sir Dugald only arrived at a total saving of 37½ million tons of coal, against the 55 millions estimated by the Committee.

Electricity for Heating.

Turning to the question of the supply of electricity for heating, Sir Dugald gave a detailed comparison of gas and electricity for domestic heating. As a result of analysis of the results of large companies and comparing total coal carbonised in the United Kingdom and the total gas produced, for a complete year's working, he estimated the average efficiency of gas production for the kingdom as 46 per cent., and the efficiency of distribution 95 per cent., giving a net efficiency of 43·6 per cent. The efficiency of the gas apparatus in use was 42 per cent., giving a final efficiency of 18·3 per cent.

Electricity generated at 1·56 lb. of coal per electrical horse-power-hour gave a thermal efficiency of production of 13 per cent. The efficiency of transmission for short distances was 90 per cent., so that the consumer received at his premises 11·7 per cent. of the potential heat. The efficiency of electrical apparatus was estimated at 59 per cent. Thus eventually the consumer used in his apparatus 6·9 per cent. of the heat units in the coal. Thus, for equal heat work, electricity consumed 2·65 times as much coal as gas. This would seriously affect the conclusions of the Committee, in so far as the replacement of gas by electricity was concerned. In his opinion, the super-stations would not justify their existence, the sweeping conclusions of the Coal Conservation Committee were unjustifiable. Small savings were possible by limiting the use of electricity to light and power, but if electricity displaced gas for heating, the coal consumption of the country would be increased. Moreover, the average heating efficiencies of coal used for domestic consumption, although not so high as gas, were higher than electric heating efficiencies.

A Broad View of the Problem.

On the assumption of the complete displacement of coal in houses by gas, a saving of 17·5 million tons was ultimately possible. Again, in the boiler house an average efficiency of 75 per cent., instead of 60 per cent. as at present, which alone might lead to a saving here of 4 million tons per annum in plant for manufacturing purposes (other than motive power). In collieries which consumed about 17 million tons of coal per annum on boiler furnaces for motive power an increase in efficiency from 55·5 per cent. to 75 per cent. would likewise save 4·4 million tons annually.

No Colossal Standardisation.

He was in accord with the desire of electrical engineers to produce motive power and light in a more economical manner than at present. The average consumption of coal per brake-horse-power for the whole country he estimated at 4 lb., but in electrical generation the low figure of 2·6 lb. per brake-horse-power hour had been attained. The purpose of reducing it still further to 1·5 lb., and even 1 lb., was commendable, but he disagreed with the colossal standardisation suggested. The notion that great gains would be derived with 20,000 H.P. turbines, and that the highest efficiencies were to be obtained with machines of 50,000 H.P. and over was erroneous. Even with a most modern plant that could be built, an increase in power from 10,000 kw. to 100,000 kw. per unit of generating plant only reduced the steam consumption per kilowatt-hour from 9 lb. to 8·5 lb. Of the whole of the 421 stations examined by Mr. Wilson, the most economical one was one with an output of 40 million units and the efficiency was 13·05 per cent. He was convinced that the use of internal combustion engines would have a great effect in future in increasing the power and reducing the fuel consumption, and this without departure from the individual generation of motive power in small units up to 3,000 H.P. The great advantage of gas power was that small units such as even 50 B.H.P. gave efficiencies quite as high as those of the larger units.

The Necessity of Free Competition.

In conclusion, Sir Dugald Clerk said that whilst steam internal combustion and gas engineers welcomed free competition with electricity supply, they considered that any attempt to crush out the smaller power units by a great Government scheme of general power production would act against the best interests of the country, both as to coal conservation and economy in cost. The lecturer urged the necessity for free competition between all forms of power in this country as essential to proper development. The present competition between gas and steam had caused a rise in the thermal efficiency of internal combustion engines from 16 per cent. in 1876, to 30-35 per cent. in 1920, and it would lead in the near future to 45 per cent. as a maximum. During the same period the efficiency of steam has risen from 8 to 20 per cent., the highest present efficiency of the best large steam turbines at full load, and in the view of Sir Chas. Parsons, this efficiency might rise in the near future to 28 per cent. If there was the free competition there would doubtless be considerable economies over the existing results shown by the Coal Controller's figures. In his view, concluded Sir Dugald Clerk, in the next 10 years we might expect the general power consumption of coal to fall from 4 lb. per brake-horse-power hour to under 2 lb., not by the extensions of electric generation and use only, but by that extension as one element combined with the increased application of economical internal combustion engines and the improvement in steam boiler and town gas and gas producer efficiency.

Correspondence.

WIRING FOR ELECTRIC LIGHT IN SMALL HOUSES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : With reference to Mr. Meffans' letter in your issue of 23rd ulto., wherein he criticises my article on " Wiring for Electric Light in Small Houses," it would appear that he has failed to interpret the true meaning of my words.

When I say that the life of a certain system of wiring, owing to inadequate mechanical protection, under given circumstances is *liable* to be short, Mr. Meffan should not credit me with the assumption that it is necessarily likely to be so. The deduction that, because a wiring installation has lasted a certain number of years without breaking down, therefore it is an absolute proof that the system employed is not liable to mechanical damage and consequent breakdown, is a similar logical fallacy to " *Post hoc ergo propter hoc.*"

One might as well argue that, because many of the wiring installations put in 10 to 15 years ago, in which insulated wires were used without any other mechanical protection, have never broken down, therefore there was no risk attached to that class of work.

The same argument would also apply to slip joint, conduit and lead-covered wires buried under plaster ; in fact, the latter system was upheld in the Law Courts a few years ago as a safe and proper system, and the arguments then used were similar to those now put forward by Mr. Meffan.

By what standard does Mr. Meffan judge ? Is he content with the fact that no breakdown occurs no matter what risk or liability is taken ? That is the standard a certain gentleman held when he contended that an installation I had condemned must be all right because he obtained a light from every lamp ! Can I persuade Mr. Meffan that the primary consideration in all electrical installations is safety ? That there are certain places where Stannos wiring may be used with advantage and safety I have already conceded ; but the limitation of this system, due to its poor protective covering, must be recognised. I must confess that Mr. Meffan's statement that he believes " many people all over the country are burying Stannos wires in the plaster " leaves me cold, as I should not be surprised to hear that certain people were burying bare wires in the plaster.

May I be allowed to remark that " an ounce of practice and experience " always appears to me to be closely related to " the little learning " that is so dangerous a thing.—I am, &c.,

London, May 3. Alan Kirk.

I.E.E. COUNCIL ELECTION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : There has been in the past some considerable criticism upon the purely metropolitan character of the Council of the Institution, and it is interesting to note that of the Council's new nominations for the forthcoming election apparently nine out of the twelve gentlemen mentioned live in or near London.

A point often raised in connection with the nomination of provincial members is the question of the expense of attending the Council meetings. Fortunately, in many cases, those provincial members who have served on the Council have had business necessitating their frequent attendance in London ; but it is obviously unfair that, failing such, the provincial members of the Council should be asked to bear the heavy personal expense involved by the proper discharge of their duties on behalf of the Institution.

One can quite understand that this question of expense restricts the choice of representatives to those members who live in or near London ; but the general body of members will, no doubt, agree that wider representation is essential to the well-being of the Institution, and therefore that the expenses of the members of Council attending Council and Committee meetings should be paid by the Institution, as is already done in the case of the Chairmen of the Territorial Centres.

Members of the Institution will note that for the present election outside nominations have been sent in in favour of at least two provincial members, neither of whom require any introduction to the members. Both have had previous experience on the Council as Chairmen of Territorial Centres, and have the welfare of the Institution and the profession generally at heart, and are real live men.

It is, perhaps, unfortunate that only a week elapses between the sending out of the ballot papers and the last day for their return.—I am, &c.,

Middlesbrough, May 3. R. M. Longman.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : The National Executive Council of the Electrical Power Engineers' Association, having considered the nominations put forward for the members' vacancies on the Council of the Institution, are of opinion that the " Council " list, as submitted, was insufficiently representative of the electricity supply industry.

To ensure on the Council of the Institution the representation which the importance of the electricity supply industry entitles it, the Electrical Power Engineers' Association recommends its members and friends who are corporate members of the Institution to record their vote in favour of the following nominees :—

C. Vernier	Chief mains engineer, Newcastle Electric Supply Company.
A. H. Marshall ...	Constructional engineer, Cleveland & Durham Electric Power Company.
F. Gill	European chief engineer, International Western Electric Company, Norfolk House, Victoria Embankment, W.C.
P. V. Hunter ...	Joint manager, Callender's Cable & Construction Company, Ltd., Hamilton House, Victoria Embankment, E.C.
Dr. A. Russell ...	Principal, Electrical Standardising, Testing and Training Institution, Faraday House, Southampton-row, W.C.

I am, &c.,
W. Arthur Jones,
London, May 3. *General Secretary,*
Electrical Power Engineers' Association.

SOME SALARY !

TO THE EDITOR OF THE ELECTRICIAN.

Sir : I would draw your attention to an advertisement which has recently appeared :—

Mr. J. W. Hame, City Electrical Engineer of York, wants a Mains Superintendent, experienced not only in high-tension, alternating current and low-tension direct current cables, but also in the construction and maintenance of overhead transmission lines, and for this experience he is prepared to pay £90 per annum plus the E.P.E.A. Awards.

Mr. Hame takes the trouble to point out that at the end of four years of presumably satisfactory service this sum would be increased by a further £42 per annum, but I am sure that what is of more interest to your readers is not what is to happen to the successful candidate in 1924, but whether the Corporation would bury his remains—there would not be much, just the bones and perhaps a little skin still attached to it—or if the sorrowing widow would have to do that out of his savings. Further, I should like to know what happened to the previous occupant of that lucrative position, and how many men the job uses up in a twelvemonth. They must have a pretty short life, else Mr. Hame would not make such extravagant promises to those who survive a year (just fancy, another fourpence a day extra) ; its worth is but little stimulant to try and keep alive for that.

Mr. Hame as well as the Corporation of York are members of the I.M.E.A. Does that body approve of such starvation wages, and if they do not approve, have they the courage to protest to their members who are bringing them into discredit, and point out that they are not only a danger to the industry, but a disgrace to their Association ?

If there were some plain speaking when required we might get a healthy public opinion formed. Besides, it is bad from a business point of view, because basic rates are being fixed for that grade, and it would pay the Corporation better to advertise at a figure that would get them a qualified man than take on a man who only values himself at £90 and be forced to pay him the wages for a good man in a short time.

What have the Associated Municipal Electrical Engineers to say to this? They are trying to get their own salaries put on a proper basis, as at present they are only being paid from two to three times the salaries of their deputies. Electrical engineers are not a superstitious race, but I would remind them of that legend of Ancient Greece which likens retribution to a bloodhound from which there can be no escape, and which sooner or later inevitably overtakes the culprit and those associated with him.

That story appears in one form or other in the literature of every nation, and is evidently the universal experience of mankind.

"As you have measured so shall it be measured to you again" is one of the few passages of the Bible the truth of which the critics do not challenge.—I am, &c.,

Croydon, May 3, 1920. John H. Parker.

WIRELESS TELEGRAPHY AND TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: "Traveller" (*see* The Electrician, February 27, 1920, p. 227) will find the equations regarding radiation resistance worked out in "The Principles of Electric Wave Telegraphy and Telephony," Fleming, p. 459. Fleming takes $\pi^2 = 10$, and so obtains $1{,}600\,\frac{h^2}{2}$, instead of $1{,}580\,\frac{h^2}{2}$, as given in Eccles' Handbook.

I do not quite understand the reference to the sixth power of the distance. If the exponential law is meant, this has been developed in different form by Austin (Bureau of Standards Scientific Paper No. 159, 1911), Watson ("Proc." Roy. Soc., October 7, 1918, "Diffraction of Waves by the Earth") and others. An interesting discussion of this law is given by Van de Pol, "Phil. Mag.," Vol. XXXVIII., September, 1919, p. 365.—I am, &c.,

Beaver Falls, Pa., April 19, 1920. Robert C. Colwell.

Electric Telpherage in Chemical Works.

In a Paper on this subject, read before the Chemical Engineering Group of the Society of Chemical Industry, Mr. H. Blyth said the telpher was a particularly convenient and simple machine for conveying any class of goods or materials over a moderate distance with a minimum consumption of power and at a low maintenance cost. A Telpher Company was formed in 1883, and one of the first telpher lines to be erected was at Weston, in Hertfordshire. It was 700 ft. long, consisted of round iron rods, and carried a total rolling load of 1 ton at a speed of 5 miles per hour. No serious attempt appeared to have been made to put telpherage upon a practical commercial footing in this country until about 1903, when Siemens Brothers, having obtained information of telpher practice in the United States, began the development of this conveying system at Woolwich, and later continued it at Stafford for a time. Some of the plants installed by Siemens Brothers might be seen at the Associated Portland Cement Company's Works, Gravesend; Peases' West Colliery, Crook, Durham; Cape Copper Company's Works, Swansea; Newport Gas Works. Later on Siemens Brothers handed the telpher business over to Strachan & Henshaw.

Progress had also been made with telpherage in Germany, but upon rather different lines, and most of the larger chemical works in Germany use telpherage for unloading barges and railway trucks exclusively. For example, Frederick Bayer & Company, at Leverkusen, used telphers for unloading salt, sodium nitrate, coal, pyrites, &c., from barges and conveying to storage; also for transmission from storage to various parts of the works. Again, at the superphosphate works of H. & E. Albert, Biebrich, making 80,000 tons superphosphate per annum, telphers were used for unloading raw materials from trucks and conveying to the stores and mills; also for bringing materials to the mixing points and handling the finished product. Telphers were also used at the Knapsack Calcium Carbide Works near Cologne.

Some of the latest applications of electric telpherage in this country were to be seen at Plymouth Gas Works, from which, in addition to gas and coke, there was a large output of chemical products; Nobel's Works, Pembrey, near Swansea; the gas works at Woolwich Arsenal, where there were eight telphers, each of 50 cwt. capacity, and about half a mile of track. At Wolverhampton, the electricity works and also at the gas works; also at Widnes, Warrington, Liverpool, Manchester, Glasgow, Hull, Dundee, &c., &c.

The modern telpher was quite different in principle from the more generally known type of transporter, which operates upon the bottom flange of an "H" beam. With the telpher system it was possible to negotiate curves of very small radius; for example, at Southampton Gas Works a telpher machine weighing 3 tons, carrying a load of 2¼ tons (total 5¼ tons), traversed a curve of 9 ft. 6 in. radius with perfect ease. Radii of 15 ft. and 18 ft. were common in gas works, where the space was often restricted, although larger radii were, of course, preferable where space permitted.

Telpherage has been very extensively adopted in gas works for handling coke and other materials, and also in electricity works for coal and ashes, notably at Stepney.

Portable Conveyors and Transporting Trucks.

In a Paper on this subject, read before the Chemical Engineering Group of the Society of Chemical Industry, Capt. C. J. Goodwin stated that, although portable conveyors had been used for years such machines had usually been crude and heavy, and it was only in recent years that their design, manufacture—and, above all, standardisation—had been studied seriously. Capital outlay and the equivalent cost of hand labour (not neglecting the possibility of subsequent increases in wages) were the chief factors in considering the adoption of portable conveyors and similar plant.

Under average conditions of loading, the following outputs were attainable from modern portable conveyors:—

Width of belt, inches.	Capacity, tons per hour					H.P. of motor required according to length.
	Coke.	Coal.	Earth.	Cement.	Fine dry Crystals.	
18	17	30	43	53	57	3 to 5
24	31	52	78	93	100	3 to 7½

The outputs of conveyors with steel flights for inclinations up to 35 deg. was about one-half of those given above, and in both cases the actual power consumption was considerably less than the rated output of the motor.

Comparison of cost as against hand labour, assuming that trucks of coal were to be unloaded and taken to a storage pile or hopper 30 ft. or 40 ft. from the railway track; further, that 20 tons had to be unloaded daily. Under the hand method this would be done by shovelling from the truck into wheel-barrows, wheeling up an inclined runway, dumping and returning empty to the truck. Two men to unload the two trucks and feed into barrows in one day. At least three men would be necessary to wheel and dump the material. Assuming daily wage of these five men averages 13s. each per day, this, for a working year of 280 days, would cost in labour £910.

This operation carried out by mechanical handling would be performed by a portable conveyor, say, 50 ft. long, working on an incline of, say, 30 deg., the receiving end remaining stationary at the truck door and the discharge end swinging round in an arc of a circle. The smallest type conveyor made would handle the quantity in less than one hour, but it could not be hand fed from the truck at this rate.

Assuming that two men were employed to shovel from the truck into the conveyor receiving hopper. These two men would unload the two 10-ton trucks in one shift. The cost worked out as follows:—

Two men at 13s. per shift each for a year of 280 days	£364
One portable 50 ft. conveyor with 3 h.p. electric motor and wheel truck. Capital cost, £500.	
Interest at 10 per cent.	50
Sinking fund, assuming the conveyor has a life of 4 years	125
Cost of electric power at 5d. per kilowatt-hour	90
Cost of one belt renewal per year	64
Repairs, &c.	25
Total	£718
Yearly saving by utilising conveyor	£192

This yearly saving would increase very greatly as the quantity of material to be handled increased—*i.e.*, as the conveyor was worked more nearly up to its capacity; but the above example was purposely selected in order to demonstrate the saving which was possible even under unfavourable conditions.

For places where no electric power was available, this machine could also be supplied with self-contained petrol engine.

Incorporated Municipal Electrical Association.

A copy of the preliminary programme of the twenty-fifth annual convention of the Incorporated Municipal Electrical Association announces that the convention will be held at Bradford and Ilkley from June 21 to 25. The headquarters of the convention in Bradford will be at the Queen's Hall, "The Windsor," Morley-street, and at Ilkley in the King's Hall, Winter Gardens.

An informal reception will be held at the Winter Gardens, Ilkley, at 8 p.m. on *Monday, June* 21, when members can register, and badges, tickets, &c., will be issued.

On *Tuesday, June* 22, the convention will be opened at Bradford, at 10 a.m., when the Association will be welcomed by the Rt. Hon the Lord Mayor of Bradford, Ald. W. Wade, J.P., and Mr. T. Roles, President of the Association and City Electrical Engineer and Manager, Bradford, will deliver an address. Subsequently a Paper on "The Design of Distributing Networks" will be read by Mr. C. A. Gillen, mains engineer, Bradford. Luncheon will take place at "The Windsor," and in the afternoon there will be visits to works in the Bradford neighbourhood. A special train will convey the party back to Ilkley about 6 p.m. In the evening there will be a reception at the Winter Gardens by the Chairman of the Ilkley Urban District Council.

On *Wednesday, June* 23, the convention will be held at Ilkley. There will be a meeting at the King's Hall in the morning, at which a Paper on "Power Station Design in Relation to Thermal Efficiency" will be read by Mr. I. V. Robinson. In the afternoon members will be left free to pay visits to places of interest in Ilkley and the neighbourhood, and arrangements will be made for a trip by motor charabanc to Bolton Abbey. In the evening the annual dinner, at which ladies may be present, will be held in the King's Hall, Ilkley.

On *Thursday, June* 24, the convention will again travel to Bradford, where a meeting will be held in the Queen's Hall of "The Windsor," at which a Paper on "Standardisation of Tariffs" will be read by Mr. J. W. Beauchamp, Director and Secretary of the British Electrical Development Association. In the early afternoon visits will be paid to works, and at 4.30 p.m. there will be a reception at the Cartwright Hall, Lister Park, by the Rt. Hon. the Lord Mayor of Bradford. In the evening a meeting, restricted to committee members of the Association, will be held in Ilkley, and there will also be a meeting of the Associated Municpal Electrical Engineers. On *Friday, June* 25, the annual general meeting of the Association will be held in the King's Hall, at Ilkley, and in the afternoon there will be a motor trip to Pateley Bridge and the Bradford Waterworks in the Nidd Valley.

As considerable difficulty is being experienced in securing accommodation for members of the Association, delegates and visitors in Ilkley and the district, it has been impossible to nominate any one particular hotel as the convention headquarters, but the Wells House Hotel, at which the members of the Council will be accommodated, may be regarded as the Council's headquarters during the convention. In order to facilitate the obtaining of accommodation those intending to be present at the convention are requested to communicate with Mr. T. Roles, Town Hall, Bradford, marking their envelopes "Hotel Accommodation." As some members may prefer to stay in Bradford or Leeds instead of in Ilkley, they are requested to state their preference when making application. It is hoped that the Midland Railway Company will be able to provide a late train service between Ilkley and those two towns, and also special accommodation for those journeying to the convention from London.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices, on receipt of published price, plus postage.]

"Electric Wiring, Theory and Practice." By W. S. Ibbetson, B.Sc. (London: E. & F. N. Spon.) Pp. viii.+463. Second edition. 18s. net.

"The Coolidge Tube: Its Scientific Applications, Medical and Industrial." By H. Pilon. (London: Baillière, Tindall & Cox.) Pp. 95. 7s. 6d. net.

"Electric Welding and Welding Appliances." By H. Carpmael, A.M.I.C.E. (London: Constable & Co.) Pp. xii.+128. 18s. net.

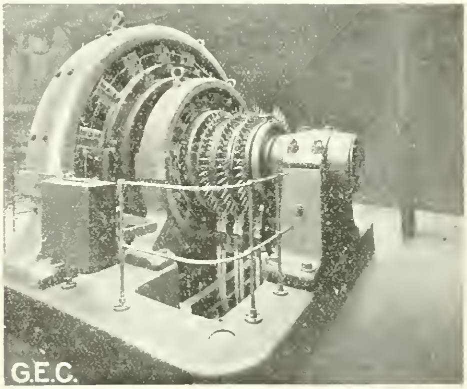
"Industrial Administration." A series of lectures by A. E. Berriman, St. George Heath, L. Hill, T. B. Johnston, A. F. S. Kent, T. M. Legge, T. H. Pear, B. S. Rowntree. (London: Longmans, Green & Co.) Pp. vii.+203. 7s. 6d. net.

"Metals in Aircraft Construction." By W. Hanby. (London: The Standard Air Press.) Pp. 112. 6s. net.

"Was Switzerland Pro-German?" By Sutton Croft. (London: Hazell, Watson & Viney.) Pp. 127.

A 1,500-kw. Rotary Converter for Battersea.

In order to increase their converting plant Battersea Borough Council recently placed an order with the General Electric Company for a 1,500-kw. rotary converter. The machine was required to convert either alternating to continuous current or continuous to alternating current with a range of voltage of 6,000 to 6,600 on the high-tension side and 470 to 530 on the continuous current side, the power factor being maintained at unity at any voltage. In order to meet this wide range an alternating current booster was fitted, having a potentiometer regulator in its field circuits. For inverted running the fields are excited from a direct coupled exciter, so as to prevent the speed from rising unduly on account of lagging wattless currents. When running alternating to continuous current the converter is used as a shunt machine, but from continuous current to alternating current a compound field is put in circuit to steady the speed during fluctuations of the inductive load. A change-over switch is mounted on the machine to cut the compound winding in and out. The converter is specified to start up from the continuous current side, but provision is made for fitting an alternating-current starting motor at a later date. A three-pole switch is mounted on the machine to open the alternating-current circuit during starting, and synchronising is effected on the high-tension side by means of an existing synchronising panel. We are indebted to Mr. Bond (borough electrical engineer) for permission to publish particulars of the machine.



VIEW OF A.C. END OF CONVERTER.

Legal Intelligence.

Taxes on Telegraphs.

On Monday the Judicial Committee of the Privy Council dismissed an appeal by the Commercial Cable Company from a judgment of the Supreme Court of Newfoundland, ordering the company to pay to the Newfoundland Government $112,000 and interest, for taxes imposed on through cables by the Telegraph (Taxation) Acts, 1905-1918. In 1905 the Legislature of Newfoundland passed an Act for the imposition of taxes on telegraph, telephone, and cable companies which were doing business in the colony and on companies which owned stations and transmitting or receiving messages in or from the colony by wireless telegraphy. A tax of $4,000 was imposed on every telegraph cable between the colony and any outside place. After the passing of the Act an agreement was entered into between the company and the Government by which the company agreed to maintain and operate a cable to be constructed by the Government from Port aux Basques, in Newfoundland, to Canso, in Nova Scotia, and the Government agreed to grant to the company the right to land any of their through cables between Europe and America and Newfoundland on terms as favourable to appellants as those under which any other cables were, or should be, granted landing rights by the Government, except any special privileges enjoyed by the Anglo-American Telegraph Company. The cable from Port aux Basques was constructed by the Government and had since been maintained by the company. In 1909 the company, by permission of the Government, landed two of their through cables at Cuckhold's Cave, near St. John's In 1911 an action was instituted by the Government against the company for taxes on those through cables. The action was determined in the company's favour by the judgment of the Judicial Committee of the Privy Council of July 10, 1912, but in March, 1918, the Newfoundland Lesgislature passed another Act definitely making the tax applicable to the Commercial Cable Company and other companies similarly situated, and to any person, firm or company owning or operating any telegraphic cable in the colony. The Act was also made retrospective from 1910, and the Government then demanded of the Commerical Company $112,000 as the tax of $4,000 per annum on their four cables from 1910. The company refused to pay. The Supreme Court decided in favour of the Government, holding that the provisions in the agreement of 1905 that appellants should have the right to land their cables on terms as favourable as those under which any other cable companies were granted landing rights, did not necessitate the Government's granting the same exemption as that which their own cable from Canso to Port aux Basques enjoyed. From that decision the company appealed.

Lord Sumner, in delivering judgment, said that their lordships concurred in the conclusion come to by the Supreme Court, and in the reasons assigned for that conclusion.

Unauthorised Connections.

At Liverpool last week John E. Pugh was charged with having fraudulently consumed electricity to the value of £1, the property of Liverpool Corporation. It was stated that defendant had entered into the occupation of a shop in Wavertree on Oct. 3 last, and it was alleged that he had been using electric light regularly from shortly after that date until an inspector detected him on Jan. 29. The meter had been removed from the shop before defendant commenced business, but certain fittings remained, and it was alleged that, at defendant's instigation, a connection with the electric main had been effected. Defendant, on whose behalf it was urged that he had not acted with fraudulent intent, was fined £5, with five guineas costs.

At Haslingden on Monday, Horace Kay, electrical contractor, was fined £10 for fraudulently consuming electricity. It was alleged that he made a connection from the Corporation mains, and though he had lamps and radiator, he had no meter. Defendant admitted that he had obtained the current in this way and said his father, the Corporation Electricity manager, knew nothing about the matter. The defence was that, in the rush of business and with a great need for light, defendant made the connection, but he put in a switchboard ready for the meter. Defendant was ordered to pay £9 for electricity consumed.

Parliamentary Intelligence.

PRIVATE BILL LEGISLATION.

The Tramways (Temporary Increase of Charges) Bill has passed the Committee stage in the House of Commons. Mr. Neal (representing the Minister of Transport) expressed the opinion that somo increase in fares for workmen and school children would have to come. The term "reasonable return on capital" was very indefinite, but it was a most useful phrase. To limit undertakings to three-quarters of their standard, or pre-war rate of dividend, was not doing justice to the shareholders. The way in which it was proposed to deal with the point was by reference to the Advisory Committee, who would consider what was a fair and reasonable return on capital. Their decision would have to be reviewed by the Minister of Transport.

The following amendment to clause 1 of the Public Utility Companies (Capital Issues) Bill was adopted in the Committee stage in the House of Lords on Tuesday: "An application by a company to a department for their consent under this Act shall be accompanied by such information, certified in such manner, as the department may require with respect to the financial position of the company, and before giving their consent the department shall require the company to give public notice of the application and as to the manner in which, and time within which, representations may be made; and to give a similar notice in writing to the Council of each county, borough or urban or rural district, within which any part of the undertaking, or limits of supply of the company, is situate."

A Select Committee of the House of Lords, presided over by Lord Chalmers, has been considering the Bill promoted by Edmundson's Electricity Corpn. and its associated companies for power to increase their charges for electric current. On behalf of the promoters it was pointed out that summer time had hit the electric light companies very hard. They had to be prepared with a large plant to meet the needs of winter time, but during the summer they got little or no return. The introduction of the metallic filament and the half-watt lamps had also reduced consumption enormously, and the consumer had, by that means, got a great deal more for his money than he got when the Board of Trade fixed the maximum at 8d. per unit. The Temporary Increase of Charges Act of 1918 had brought no relief to the companies. The promoters asked for a uniform maximum rate of 1s. 2d. on a sliding scale, which would allow them to retain no more than 6 per cent. on their capital unless they reduced the price below 1s., and would allow them to pay ½ per cent. extra on their capital for every halfpenny reduction in price of current below 1s. per unit.

After hearing the promoters' case and the report of the Electricity Commissioners, but without calling upon the opposition, the Committee decided against the Bill.

The Bill of the South Wales Electrical Power Company, which authorises the raising of £500,000 additional capital for the purposes of the undertaking by the issue of prior lien debentures, has been approved by the Unopposed Bills Committee of the House of Commons and passed for third reading.

The Pontypridd Urban Council Bill, which confers powers to construct additional tramways and to fix fares, &c., has been passed by the Local Legislation Committee of the House of Commons.

Electricity Supply.

It is now proposed to introduce electrically-driven laundry machinery at the Westminster public baths and laundry.

The sites and building sub-committee of Wolverhampton Education Committee recommend that £1,400 be spent upon the electric lighting of five schools.

Rawtenstall Council have been authorised by the Electricity Commission to proceed with the proposed extension of the electricity works at Hareholme, at an estimated cost of £116,000.

Kingussie Town Council is considering a proposal to introduce electricity supply, and a preliminary report has been prepared by Mr. Williams, of the North of Scotland Electric Light & Power Company.

The Lighting Committee of Haswell (co. Durham) Parish Council, which is considering the question of street lighting by electricity, is endeavouring to make an arrangement for a supply from the local power company.

The Oakengates Urban Council, being dissatisfied with the action of the local gas company in connection with the housing schemes, a committee has been appointed to consider what other method could be devised for lighting the district.

The Electricity Commissioners have approved the proposal of Leicester to purchase the Freemen's Meadow site for a new power site, which will have an ultimate capacity of 50,000 kw., but the first instalment of the plant will be only 20,000 kw.

Walsall Corporation has decided, owing to the increasing demand for electric current, to make extensions of mains and feeders at a cost of £1,130, and also to purchase a transformer and switchgear at a cost of £400 in connection with a new bulk supply for the Birchills district.

The borough Electrical Engineer of Bolton (Mr. W. J. Wood) has arranged for the purchase of a 6,000 kw. turbo-alternator for immediate delivery and installation at Back o'th'Bank Works to be ready for use during next winter. Local traders are agitating for preferential rates for shop lighting.

Blackpool Electricity Committee have received an award giving a war bonus of £30 per annum to five members of the technical staff from Jan. 1 last. The coal position continues to be serious. In pre-war days the department carried a stock of 2,000 tons, but at present the stock is under 250 tons.

We learn that a scheme for the supply of electricity in the whole of the East of London by one authority, which is projected by Poplar Borough Council, is to be considered by a conference of Greater London authorities. Though no particulars are yet available for publication, it is stated that large stations will be erected on the north and south of the Thames to supplement the existing means of supply.

So great is the demand for electrical energy for power and lighting in Stoke-on-Trent that extensions of plant and mains are urgently needed. The Electricity Supply Committee proposes to remove two small sets at each of the sub-works at Stoke and Burslem, and to substitute two 1,000 kw. turbines sets, at an estimated cost of £60,000, and to install a 5,000 kw. turbo-alternator, with boilers and other plant at the central power house, at a cost of £200,000. The Corporation has approved these proposals, and has applied for permission to borrow £260,000.

Extensions of the plant and mains, estimated to cost between £15,250 and £20,000, have been approved by Aberdeen Electricity Committee. It is proposed to spend £2,311 on extending the supply cables to the Council's housing scheme at Torry, £4,693 for the erection of a sub-station in King-street, and another sub-station at Jamieson' Quays. The city electrical engineer, Mr. J. Alex. Bell, reports that there is an increasing strain on the Dee village generating station; the average maximum load per day is fully 2,000 kw. above last year, and unless immediate steps are taken, it will not be possible to steam next winter's load. It has, therefore, been decided to put in another boiler, which with foundations, pipe work, induced draft fan, motor, &c., will cost £8,250.

At a recent conference of representatives from Buxton Corporation, the New Mills and Whaley Bridge Urban Councils and the Chapel-en-le-Frith Rural Council the question of forming a Joint Electricity Authority for the area was considered. Mr. C. H. Wordingham, consulting engineer, attended and explained the situation created by the Electricity (Supply) Act. It was thought that it might be practicable for the districts mentioned to join with Buxton in a scheme for the supply of electricity over the area, but it was decided that, owing to the great cost involved, especially in transmission over a big stretch of country, the scheme was impracticable, the opinion being that New Mills should have a scheme of its own. The New Mills Council has now decided to consider the question without delay.

The Manchester Electricity Committee expects, in the absence of prolonged labour troubles, that in the current year it will be able to meet all charges, to provide the usual rate aid (if required) and to make a small contribution to reserve. It does not contemplate any further increase of prices, but it thinks that, in view of the heavy interest and debt redemption charges during the construction of the Barton super-power station, which cannot be productive for three years, it would be desirable to forgo the annual toll in aid of the rates. During the past year it has been able to liquidate the deficit of £13,605 on the previous year, to pay the rate aid of 1 per cent. on capital (amounting to £33,255 for 1919 and £34,952 for 1920), and to reopen the reserve fund with £2,346. Since last December the charges for electricity for lighting have been 100 per cent. higher than the pre-war figure, and 125 per cent. higher for power.

In a report on the Barnstaple electricity undertaking, Mr. J. S. Highfield states that the present plant is not so economical as plant that could be purchased to-day. Consequently, they were driven to make very substantial increases in prices. They were charging a fair price for public lighting, and increased revenue should be derived from private lighting and power supply. The maximum price authorised was 8d. per unit, and he recommends the Council to apply for sanction to increase this to 1s. 2d. per unit. The proposed installation of two 500 kw. d.c. steam turbine sets and a boiler would be insufficient to carry the present load. Two additional boilers and engine sets would cost £28,000, and would enable them to supply the present load comfortably, together with the shipyard, but would not allow for further extensions. Mr. Highfield, however, recommends two additional boilers and two 500 kw. steam turbine sets, which would cost £39,000, and leave a margin for dealing with further business without the necessity of enlarging the buildings, and would also result in smaller running costs. After a load of 600 kw. had been reached, there would be an estimated profit of £1,902. Mr. Highfield also deals with the possibility of utilising water-power: but the quantity of power would be relatively small, and, consequently, could be only supplemental to the steam plant. In the North Devon area the towns are small and distances relatively large, and Mr. Highfield thinks the power requirements at present were too small to justify the expense of inter-connecting mains.

Electric Traction.

Preston Tramways Committee propose to carry out renewals of the permanent way at a cost of £10,000.

As there is a deficit of £2,453 on the first quarter's working of the Barrow tramways since they were taken over by the Corporation, the fares are to be increased all round.

The General Purposes Committee of Blackburn Corporation recommend that the salary of Mr. J. H. Cowell, tramways manager be increased from £600 to £800 per annum.

Aberdeen Tramways Committee has decided, in view of the increased cost of labour and materials, to shorten the penny stages, to abolish halfpenny fares, to increase the price of composition tickets by 100 per cent., and to increase the price of children's tickets by 50 per cent.

Like other tramway undertakings, Liverpool Tramways Committee finds it necessary to make a revision of fares to meet increased expenses, and the Council is recommended to authorise a charge of 1d. per mile or part of a mile; the present 1½d. and 2½d. fares to be abolished.

In the report of the District Auditor on the accounts of the London County Council for the year ended March 31, 1919, it is stated that any advantage gained by the revision of tramway fares, which resulted in an increase of 21·19 per cent. for the year, had been far more than counter-balanced by the increase in working expenses of 34·33 per cent.

By the decision of Glasgow Corporation to increase the tramway fares there is now no tramway undertaking in the United Kingdom working on a pre-war basis. Strenuous but unsuccessful efforts were made to maintain the halfpenny fares, and it was agreed to add a halfpenny to each of the present fares. It was, however, decided that 12 tokens to cover the present halfpenny distances should be issued for 9d.

The following short list has been selected by Dundee Tramways Committee out of the candidates for the position of tramways manager: Samuel Morrison, principal assistant, traffic department, Glasgow; James H. Menzies, depot superintendent, Dundee; T. G. Richardson, manager, Colne Corporation Tramways; Adam Anderson, manager, Peterborough Electric Traction Company; G. Brander, manager and engineer, Dundee, Broughty Ferry & District Tramways Company; and H. Clayton, assistant engineer and manager, Preston Tramways.

Manchester Tramways Committee is faced with estimates for the ensuing year that show a big deficit. The approximate expenditure is £1,988,530, and the estimated income (apart from any increase in fares) is only £1,635,000. The committee estimate that it will be necessary to raise the fares to produce £353,530, including £115,260 for relief of rates, but they suggest that this contribution to the rates will have to be discontinued. It is proposed to spend £100,000 on buildings, and an additional £250,000 on cars and other rolling stock.

The District Council of the National Joint Industrial Council for Tramways has ratified an advance of 8s. a week to Manchester and Salford tramwaymen and the first payment at the new rate will be made this week. The award dates back to March 29, and another 1s. a week will be given next month. A special committee has been appointed to deal with the other districts in Lancashire and Cheshire.

The District Council for Yorkshire, North Derbyshire and Lincolnshire failed to arrive at an agreement on Tuesday and decided to refer the matter back to the National Council for decision, with new proposals from both sides. Already the men's demands have been conceded in Bradford, Hull and Huddersfield.

Liquidations.

Electric & General Works, Ltd., is being wound up voluntarily, and Mr. F. H. Christlieb, 36, King-street, Cheapside, London, E.C. 2, has been appointed liquidator. A meeting of creditors will be held at 36, King-street, on May 17. Claims to the liquidator by June 30.

Albert Edward Channon, Humphrey Stanton Nadin and Cyril Geo. Channon (trading as A.E. Channon & Company), electrical engineers, 8, Orrisdale-terrace, and 425, High-street, Cheltenham, have been adjudicated bankrupt. The first meeting of creditors will take place on May 14 at County Court Buildings, Cheltenham, and the public examination on May 27 at the Court House, Cheltenham.

Institution Notes.

The annual dinner of the Engineering Society of the University of London will be held at Frascati's Restaurant on Tuesday, May 18, at 7 p.m. Tickets are obtainable from the Secretary of the Society at University College, Gower-street, London, W.C.1.

The Institute of Industrial Administration recently held their first general meeting, 150 members being present. As an immediate step in the work of the Institute, a series of lectures on the "Organisation of Payment by Results" will be given at the Central Hall, Westminster.

At the meeting of the Liverpool Wireless Association on April 28, the subject was "Battery Power for Use with Valve Circuits." The next meeting will take place on the 12th inst. New members are invited by the hon. sec., Mr. S. Frith, 5, Cambridge-road, Crosby, Liverpool. Subscription, 5s. per annum.

It has been decided to form a Wireless Society for Cardiff, South Wales and Monmouthshire, and Mr. W. A. Andrews, B.Sc., has been elected president, Mr. W. J. Stephens vice-president, and Mr. A. E. Hay, of 6, Oxford-street, Mountain Ash, hon. secretary. The membership fee is 5s. per annum, and the next meeting will be held on May 13.

The Committee of Management of the Benevolent Fund of the Institution of Mechanical Engineers direct attention to this Fund, which is available for the financial assistance of those who are or have been members of the Institution, and for the relatives or dependents of such persons. It is thought that possibly some who are qualified to receive assistance and who are in financial hardship, owing to causes arising out of the war or otherwise, may not be aware of its existence. Forms of application for assistance may be obtained from the Hon. Secretary of the Benevolent Fund, Storey's Gate, Westminster, S.W. 1.

The first annual general meeting of the Liverpool Sub-centre of the North-Wesern Centre of the Institution of Electrical Engineers was held recently, when the following members were elected as committee: *Chairman*, Mr. H. Dickinson; *Vice-chairman*, Messrs. G. H. Nisbett and B. Welbourn; *Hon. Secretary*, Mr. O. C. Waygood; *Ordinary Members*, Messrs. D. Bates, E. A. Bayles, L. Breach, T. D. Clothier, J. Hamilton, H. H. Harrison, B. T. Hawkins, E. M. Hollingsworth, W. Lang, P. Priestley, P. J. Robinson and J. Shaw.

In the annual report it is stated that the Committee of the N.-W. Centre convened a meeting which was held on Nov. 21, 1919, at Liverpool University, and was attended by about 60 people, including several representatives of the N.-W. Centre Committee. The chairman of the N.-W. Centre, Mr. J. A. Robertson, took the chair and encouraged the local members to form a sub-centre. A provisional committee was appointed to go into the necessary organisation and arrange meetings for the remainder of the session. To define the area of this sub-centre and to draw up a constitution a sub-committee was formed. It was recommended by this Committee that the Liverpool area should be included by straight lines between the towns of Southport, Prestatyn, Wrexham, Warrington, Wigan and back to Southport. Southport and Wigan were included in the Preston area; but the members in those towns were to be invited to decide to which sub-centre they wished to become attached. At its inauguration the members of the sub-centre numbered 220, but by April, 1920, the number had risen to 294, a satisfactory rate of progress.

The Council of the Institution of Civil Engineers have made the following awards for Papers read and discussed during the session 1919-1920: Telford Gold Medals and Telford Premiums to Mr. D. Lyell, C.M.G., C.B.E., D.S.O., Mr. J. K. Robertson and Major-General Sir Gerard H. Heath, K.C.M.G., C.B., D.S.O., R.E.; a George Stephenson Gold Medal and a Telford Premium to Mr. Maurice F. Wilson: a Watt Gold Medal and a Telford Premium to Mr. P. M. Crosthwaite, B.A.I.; Telford Premiums to Major E. O. Henrici, R.E., Sir Francis J. E. Spring, K.C.I.E., M.A.I., Mr. F. O. Stanford, O.B.E., Mr. James Mitchell, Mr. J. W. Sandeman, and Mr. A. R. Fulton, D.Sc. The awards for Papers published in the "Proceedings" without discussion will be announced later.

At the annual general meeting of the Institution of Civil Engineers the following officers were elected for the year 1920-1921: *President:* Mr. J. A. Brodie; *Vice-Presidents:* Mr. W. B. Worthington, Dr. W. H. Maw, Mr. Charles L. Morgan, Mr. Basil Mott; *Other Members of Council:* Mr. E. A. S. Bell, Dr. C. C. Carpenter, Col. R. E. B. Crompton, Mr. Maurice Deacon, Sir Archibald Denny, Sir W. H. Ellis, Mr. Albert Gordon, Mr. W. W. Grierson, Sir R. A. Hadfield, Sir Brodie H. Henderson, Mr. E. P. Hill, Mr. G. W. Humphreys, Mr. Summers Hunter, Mr. H. G. Kelley, Mr. C. R. S. Kirkpatrick, Mr. James Marchbanks, Mr. H. H. G. Mitchell, Engr. Vice-Admiral Sir Henry J. Oram, Mr. F. Palmer, Capt. H. Riall Sankey, Sir John F. C. Snell, Mr. W. A. P. Tait, Mr. A. M. Tippett, Mr. E. F. C. Trench, Prof. W. H. Warren, and Sir Alfred F. Yarrow. This council will take office on the first Tuesday in November, 1920.

The annual meeting of the Royal Institution was held on Saturday last, Sir James Crichton-Browne in the chair. The following were elected as officers for the ensuing year: *President:* The Duke of Northumberland; *Treasurer:* Sir James Crichton-Browne; *Secretary:* Col. E. H. Hills; *Managers:* Dr. T. Brown, Messrs. J. H. Balfour Browne, J. Y. Buchanan, and W. R. Burdett-Coutts, Sir J. J. Dobbie, Dr. J. D. Grant, Dr. D. W. C. Hood, the Rt. Hon. Earl Iveagh, Mr. H. R. Kempe, Sir Ernest Moon, the Hon. Sir Charles Parsons, Sir James Reid, Sir E. Rutherford, the Rt. Hon C. Scott-Dickson, Sir H. Wood.; *Visitors:* Sir Hugh Bell, Sir W. H. Bennett, Messrs. W. R. Bousfield, J. G. Bristow, F. Clowes, Montague Ellis, W. E. L. Johnston, J. R. Leeson, T. Bell Lightfoot, F. K. McClean, W. S. Norman, H. M. Ross, J. Shaw, T. H. Sowerby and Sir Almroth Wright.

Miscellaneous.

Wireless Telegraph Stations are being erected under the supervision of a British engineer between Peking and the farthest limits of Chinese territory in Turkestan.

Last week Robert Henderson, an electric crane driver, employed by Messrs. John Readhead & Sons, South Shields, received a Fatal Shock while cleaning his crane. He was warned that the wires were alive. Another unfortunate accident occurred to Thomas Jenkins, who was killed when connecting an electric boring machine at the Ton Phillip Rhondda Colliery, Kenfig Hill.

An inquest was held at Old Trafford, last week, on Arthur Alcock, who died as the result of an electric shock whilst following his employment as assistant foreman at the Metropolitan-Vickers' Electrical Company, Trafford Park. Deceased was taking the temperature of some transformer oil, and over the tank was an electric wire carrying energy at 5,750 volts, which deceased had himself fixed up the previous day. Owing to forgetfulness Alcock did not switch off the current, and he fell from the ladder on which he had been working. Artificial respiration was resorted to, but without success. The live wire had been put up temporarily for testing purposes, and deceased had warned others about the danger of not switching off the current. A verdict of accidental death was returned.

On April 30, at the Vine Hotel, Stafford, Mr. J. C. Wilson and Mr. J. W. Howard, respectively chiefs of the d.c. and a.c. design departments of Siemens' Works were entertained to dinner by the technical staff of the works. The occasion was their departure to join the Central Design Committee of the English Electric Company in London. Mr. Wilson and Mr. Howard have been at Stafford Works for many years, and both have attained considerable popularity in their own and other departments. Mr. W. Marden, chief designer, who was in the chair, proposed "The Guests," in an interesting speech, in which he traced the development of the Siemens' machines. The guests having responded, Mr. Ben Duke proposed "Siemens' Works, Stafford," which was replied to by Mr. W. Parker, the Works Manager.

The fact that an average speed of 109·89 miles per hour was maintained by Lieutenants. Holthouse and Debeer in the 1,000-miles Flight between Cape Town and Pretoria, which was accomplished in 9 hours 6 minutes, speaks well for the efficiency of the British Engine and British Magnetos which form the propelling unit of the South African Government Aeroplane "Vorteker" which was used for the flight. Recently British magnetos have also been proving their superiority in the international motor boat races at Monaco. In the successes achieved by the Sunbeam engine in the cruiser class from Lyons to Monaco, in the 21 footer class for the championship of the British Motor Boat Club, and in the championship for the sea, an important part was played by British magnetos. In the first mentioned event a speed of 70 miles per hour was accomplished—a severe test for any magneto.

The Air Ministry announces that an Aeronautical Research Committee has been formed for the purpose of advising on scientific and technical problems relating to the construction and navigation of aircraft, undertaking such research or experimental work as is proposed to the committee by the Ministry, and to initiate any research work which the committee considers to be advisable, &c. The committee will also take over responsibility for the Air Inventions Committee, will promote education in aeronautics by co-operating with the governors of the Imperial College and co-operate with any research association that may be established. The members of the committee are: Prof. Sir Richard Glazebrook (chairman), Wing-Commander W. D. Beatty, Lieut.-Colonel E. Gold, Air-Commodore H. R. M. Brooke-Popham, Wing-Commander T. R. Cave-Brown-Cave, Prof. L. Bairstow, Prof. Sir J. E. Petavel, Mr. Alec Ogilvie, C.B.E., Mr. H. White Smith, C.B.E., Mr. J. D. Siddeley, C.B.E., Prof. Horace Lamb, Prof. W. E. Dalby, Prof. B. M. Jones, Mr. G. I. Taylor and Mr. H. T. Tizard, M.A. Mr. J. L. Nayler, National Physical Laboratory, is secretary; and Mr. J. G. Gibson (Air Ministry), assistant secretary.

Messrs. George Ellison, of Birmingham, is one of many firms who have done much to develop athletics, social and welfare work among their employees. At the close of the war, the firm's employees showed a desire for recreation and sports. The head of the firm fostered the movement in every way; the workpeople were encouraged to form football, hockey, cricket, swimming and other sections of a comprehensive athletic and recreation club. This is now a vigorous institution controlled by committees elected by the workers. The football section in particular has won laurels, as its records show. In the 1918-19 season they were champions of the 5th Division of the Birmingham and District Works League, winners of the Mitton Challenge Cup and of the Cadbury Challenge Shield. In 1919-20 they were finalists for the Aston Villa Challenge Cup, semi-finalists for the Prudential Victory Cup and winners of the Vernon-Austin Challenge Cup. In the last competition the team had a stiff struggle with Harper, Son & Bean's men, drawing two games before beating them by 2 goals to none. They have only suffered one defeat in the Works League, 1st Division, to which the club has been promoted, and but for the F.A. ruling that all fixtures must be played by May 1, they think they would probably have been the League Champions. In addition to the 1st team there are a 2nd men's football team and a boys' team. The boys have won 20 out of 22 games and scored 164 goals against 31. They are considered to be the most finished boys' football team in the Midland District.

Mr. Geo. Swales, secretary of "Ellison's" Athletic & Recreation Club, states that the senior team is willing to play a match against an amateur side from any electrical works in London or the provinces. If the challenge is accepted a game could be arranged during this month.

Educational.

The Vice-Chancellor of Cambridge University has received £1,000 from Mr. Edward Hopkinson, M.P., and £500 from Sir William Mather towards the augmentation of the endowment fund for the proposed Hopkinson Professorship in Thermodynamics.

The University of Oxford has received an offer from Mr. Edward Whitley of £10,000 towards the endowment of a Professorship of Biochemistry, and a donation of £5,000 from the British Dyestuffs Corpn. towards the cost of extending the organic chemical laboratory.

Mr. A. T. Morris, B.Sc., A.M.I.E.E., has been made superintendent of the testing department of the Faraday House Electrical Engineering College, in succession to Dr. F. T. Chapman, M.I.E.E., who has been appointed one of H.M. inspectors of technological education. The Rev. L. Van Vestraut, M.A., has been appointed chief assistant in the testing department; Mr. J. K. Catterson-Smith, M.I.E.E., has been appointed lecturer on dynamo design; and Mr. A. Regnauld, B.Sc., A.M.I.E.E., superintendent of the workshop department.

Sir Richard Gregory, who presided over the recent annual dinner of old students of the Royal College of Science (London), referred to the efforts which were being made, particularly in Manchester and Liverpool, to arouse local enthusiasm for the work of their universities and higher technical institutions. There should, however, be some co-relation between these different institutions, instead of each of them taking independent action almost suggestive of competition for public support. The time had come when there should be a comprehensive survey of the position of university and higher technical education in the country.

Lord Crewe, as chairman of the governing body of the Imperial College of Science since its foundation in 1907, said they were now not content to be merely a school of any university, however distinguished. He saw insuperable difficulties in a closer connection, which, after all, could only be a connection of absorption between themselves and London University. Though there was no precedent for a purely technological university or for the granting of degrees by a college not of university rank, there was no precedent for a population of 8,000,000 with but one university. The West Riding of Yorkshire had two universities with less than half the population; Lancashire, with a little more than half the population, had also two, while New York was full of universities. The educational authorities had enough to do without embarking on the difficult task of trying to combine the activities of London University and the Imperial College in one entirely unprecedented unit.

When Bristol University was established in 1909 it possessed one of the best equipped engineering faculties in the United Kingdom. Since then great improvements have taken place in many other universities, and the Merchant Venturers, in whose college the faculty is provided and maintained, have decided to undertake considerable extensions. They are roofing in a large space at the back of the college which will provide a new laboratory 68 ft. by 50 ft. At present the testing laboratory in the department of civil engineering and the heat engines laboratory in the department of mechanical engineering share a large room; but in future this will be devoted to civil engineering, and will enable additional apparatus to be installed. The new laboratory will be allotted to the mechanical engineering department, and will contain the present experimental steam engines with a new condensing plant, cooling tower, an additional single-cylinder engine, a compound marine engine, an injector, an additional turbine and a new Diesel engine, together with measuring instruments. An additional workshop for mechanics engaged in producing apparatus for research work and for students will be equipped as well as a new metallographic laboratory. The civil engineering laboratory will be equipped with additional testing machines. The laboratory accommodation at the disposal of the department of electrical engineering will be doubled, three of the present classrooms being used for this purpose. The equipment will be improved by the addition of a booster and some a.c. machines. Additional electric standards, a new photometric outfit and a large testing set will also be provided. For the department of automobile engineering a new experimental motor car is on order, and the other additions will include a Froude dynamometer, additional experimental engines, &c. The equipment of the boiler house will be improved by providing an economiser, feed water heater, an electric superheater, a CO_2 recorder and an additional pyrometer. The machines in the main engineering workshop have been largely worn out in training men and women for munitions factories, and the shop will, therefore, be re-equipped with a new universal milling machine, a number of new lathes and an oil furnace with accessories for melting brass, &c. The total cost of the alterations and additions will be about £11,000.

Personal and Appointments.

Dr. L. Bairstow, C.B.E., F.R.S., has been appointed professor of aero-dynamics at the Imperial College of Science, South Kensington.

Recent changes of staff made by the First Commissioner of Works include the promotion of Mr. H. Baines, C.B.E., to the position of chief mechanical and electrical engineer of the Works Division.

Amongst the Civilian War Honours conferred recently, Mr. Edwin Thorley Parker, son of the late Mr. Thomas Parker, of Wolverhampton, was awarded the O.B.E. for work as technical adviser and chief dilution officer of the labour supply department in the West Midlands Division.

Sir Richard Glazebrook and Sir Arthur Schuster are treasurers of the fund which is being raised by the Royal Society and Cambridge University for a memorial window to Lord Rayleigh in Westminster Abbey, and to promote research in some branch of science with which Lord Rayleigh was associated.

Tenders Invited and Accepted.

Lincoln Corporation want tenders by May 24 for coal-handling plant. Specifications from Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, London, S.W.1.

Launceston (Tasmania) Corporation require tenders by 3 p.m. June 7 for one 1,000 k.v.a. Hydro-turbo-alternator, with Switchgear, &c. Specification from the City Electrical Engineer.

Glasgow lighting department require tenders by May 10 for year's supply of electrical fittings and accessories, copper, lead, oils, &c. Specifications from the lighting department, 20, Irongate, Glasgow.

Sheffield Health Committee invite tenders for 10 electric tipping wagons for house refuse collection. Tenders (with complete specifications) to be sent to the superintendent, Mr. J. A. Priestley, by May 10.

Tenders are required by June 28 for two electric cranes (30 tons and 10 tons) for the new dry dock and No. 61 of the Bassin Lefebore, Antwerp. Specification from the Bourgmestre d'Anvers, Hotel de Ville, Antwerp.

Hammersmith (London) Borough Council invite tenders for supply of two 10,000 kw. Turbo-alternators with condensing plant. Specifications from the borough electric engineer (Mr. G. Gilbert Bell), and tenders to the Town Clerk by May 21.

Colwyn Bay Urban Council invite tenders for h.t. Feeder Cables, Rotary Converter and Static Transformer (or Motor Converter Equipment) and Switchgear. Specifications from the Electrical Engineer, and tenders to the Clerk by noon May 15.

Manchester Electricity Committee require tenders by June 7 for supply and erection at Barton power station of 33,000 volt and 6,000 volt main switchgear, pressure testing switchgear, &c. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Belfast Corporation invite tenders for the manufacture and erection at the East Bridge-street electricity works of coal handling plant. Specifications from the city electrical engineer, Mr. T. W. Bloxam, M.I.E.E., and tenders to the Town Clerk by May 19.

The New Zealand Public Works Department, Wellington, require tenders by June 30 for supply of 4,300 h.p. water turbine (section 79) and 3,000 kw. generator (section 80) for the Lake Coleridge scheme. Specifications from the Public Works Offices, Christchurch (Electrical) and Wellington.

The Agent-General for Victoria invites tenders for four 4,500 kw. and eight 1,000 kw. 1,500 volts converter traction sets for the Melbourne and suburban electric railways. Specifications, &c., from the Agent-General, Melbourne-place, Strand, London, W.C.2; and further information may be obtained from the consulting engineers (Messrs. Merz & McLellan), 32, Victoria-street, London, S.W.1. Tenders by noon May 31.

Aberdeen Electricity Committee has ordered a boiler from Babcock & Wilcox at £4,205.

The Visiting Committee of the East Sussex County Mental Hospital have accepted the tender of Batteries, Ltd., of Redditch, for the supply of a nife battery (nickel-iron-alkaline), consisting of 364 cells with a capacity of 310 ampere-hours.

Stepney (London) Electricity Committee has accepted the tender of the Sloan Electrical Company (the lowest tender) for 5,000 pairs of yellow flame carbons at £112 10s. (Three tenders were received, the highest being £147 11s. 10d.) and that of W. Lucy & Company (the lowest tender) for six feeder boxes at £198. (Four tenders were received, the highest being £266 3s. 6d.)

Business Items, &c.

The Coventry Electrical & Engineering Company have secured the Coventry agency for Wild-Barfield electric furnaces, and they are having a demonstration furnace erected at their address, 23-24, Hartford-street.

The Business Exhibition, which is being held at the Agricultural Hall, Islington, N., was opened on Tuesday by Mr. Stanley Machin. Among the exhibits are displays of electric fittings, lamps, &c.

The offices of the Electrical Components, Ltd., manufacturers of and factors in electrical engineering supplies, have been removed to "Components House," 90, St. Charles-street, Snow-hill, Birmingham, where all future communications should be addressed. Telephone, Central 2015.

John Wakerley and Wm. Alfred Webb, the younger, electrical contractors, 266, Witton-road, Aston, Birmingham, have dissolved partnership. Debts by Mr. Wm. A. Webb, the younger, who continues the business as Wakerley & Webb.

An important sale by auction of electric generating plant, electric meters, cables and electrical accessories, telephone and telegraph instruments, &c., will take place at Woolwich Arsenal and Dockyard on June 9 and June 14. Catalogues from the auctioneers (Messrs. J. T. Skelding & Company), 42, Gresham-street, London, E.C. 2.

The Bastian Electric Company, Ltd., announce that their commercial department has been removed to Maymore Works, Wharfdale-road, Tyseley, Birmingham, where all communications relating to orders, accounts, &c., will be dealt with. The offices at 185, Wardour-street, W.1, are being retained as the technical department, and samples of the Company's products can be seen there as heretofore. The Company are now able to manufacture under ideal conditions, having made a special exclusive manufacturing arrangement with Messrs. May & Padmore, Ltd., of Birmingham, whose new large modern factory is equipped with the most modern plant and tools. New designs of electric fires, flat irons, toasters, ovens, &c., are in hand, and will be produced shortly for the coming season.

Catalogues, Price Lists, &c.

In a pamphlet which has been issued by Lesco, Ltd., Lloyds Bank-buildings, Manchester, particulars of the design and manufacture of the "Lesco" lamp-holder are given. A description of this holder, which is made according to Hope's provisional patents, appeared in The Electrician for Feb. 13 last.

In a folder issued by the Powerite Steam Jointing Company, Ltd., 16 and 17, Devonshire-square, E.C.2, some particulars are given of "Powerite" steam jointing. It is claimed that this jointing will never burn out, blow out or squeeze out; it will make a perfectly tight joint on the most uneven surfaces, and it will not need replacing for years. It is said to be unaffected by the action of steam, acid, oils and alkalis, and to be unequalled for resistance against high or low pressures, saturated or superheated steam. It never gets hard in store and always remains flexible. The company supplies "Powerite" in sheets and rolls of any size and thickness, and among its users are several electrical firms.

The General Electric Company, Ltd., 67, Queen Victoria-street, E.C. 4, have prepared an attractive hanging or counter card, which will form a very effective advertisement of the Osram G.E.C. lamps. The card, which is printed in colours, has a striking reproduction of a hornbill, which is bound to catch the eye at once. The same design is available as a label for sticking on trade literature, invoices, &c. Copies of the card or label may be obtained from the company. The accompanying illustration shows the label.

IF YOUR "BILL" IS LARGE
USE
Osram
G.E.C.
LAMPS

Patent Record.

SPECIFICATIONS PUBLISHED.

The following obstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 Specification.

140,476 B.T.-H. Co. (G.E. Co.) Regulating mechanism for controlling speed of induction motors. (13/11/16.)

1917 Specifications.

40,108 Bransom. Electrically-driven gramophones. (29/8/17.)

1918 Specifications.

118,843 Jungner. Primary galvanic batteries with unalterable electrolyte. (4/9/17.)
121,957 Hultman. Group switching arrangements for automatic or semi-automatic telephone exchanges. (24/12/17.)
125,271 Holslag. Method of electric arc welding, cutting and repairing. (30/4/18.)
140,123 Latour. Telephone apparatus. (5/9/17.)
140,133 Latour. Telephonic apparatus. (3/10/17. Addition to 140,123.)
140,134 B.T.-H. Co. & Whittaker. Dynamo-electric machines. (15/11/18.)
140,138 Imbery. Electric muffle furnaces. (4/6/19.)
140,491 Crochat. Arrangement of several electric generating groups for the purpose of supplying an equal number of electric motor groups. (14/11/17.)
140,500 Elleson. Electric accumulator plates. (25/11/18.)
140,506 Latour. Lamp telephone relays. (5/12/17.)
140,518 North & Allen. Magneto-electric machines. (24/12/18.)
140,519 North & Allen. Magneto-electric machines. (24/12/18.)
140,520 North & Allen. Interrupter devices for magneto-electric machines. (24/12/18.)

1919 Specifications.

123,767 Lubeck. Electric motor-cars. (25/2/18.)
126,607 Benjamin & Nilson. Electrical switches. (4/5/18.)
124,729 Chatwin. (Christ Sons Co.) Electrical terminal. (17/3/19. Convention date not granted.)
134,226 Siemens & Halske Akt.-Ges. Electrical means for facilitating navigation on pre-determined courses. (11/7/18.)
136,570 Angus. Apparatus for electrically controlling railway trains or vehicles through the track. (10/10/17.) Divided application on 15,863/18.)
136,571 Angus. Apparatus for electrically controlling railway trains or vehicles through the track. (10/10/17. Divided application on 15,863/18.)
140,166 B.T.-H. Co. (G.E. Co.) Electrodes for vacuum discharge devices. (10/2/19.)
140,179 Crabtree. Electric switches. (20/2/19.)
140,180 Crabtree. Electric switches. (20/2/19.)
140,181 Crabtree. Electric switches. (20/2/19.)
140,182 Crabtree. Electric switches. (20/2/19.)
140,220 B.T.-H. Co. (G.E. Co.) Excitation of dynamo-electric machines. (1/4/19.)
140,227 Hill. Means for preventing sparking in appliances for making and breaking electric circuits. (7/4/19.)
140,285 B.T.-H. Co. (G.E. Co.) Regulating systems for alternating-current circuits. (16/6/19.)
140,298 Runbaken & Torrance. Magnetos. (18/7/19.)
140,318 Dean & Redmayne. Contacts for electric switches, fuses and the like. (5/9/19.)
140,332 Western Electric Co. Electrical protective devices. (14/2/19. Divided application on 135,389.)
140,346 Dechelle. Electric lighters. (22/3/19. Addition to 129,653.)
140,525 Kirk. Electric generating arrangements for vehicles. (2/1/19.)
140,528 Wilson. Control of hydro-electric power stations. (4/1/19.)
140,538 Franklin. Wireless transmission systems. (17/1/19.)

The spaced aerials are each provided with an oscillation generator of the thermionic three-element type, power being preferably supplied to each generator from some common source, and the frequency of each generator is controlled from a central independent generator, the oscillations of which are led to the grid circuits of all the generators coupled to the aerials so as to control the frequency and phase therein.

140,554 Grime & Mather & Platt. Starting and synchronising of synchronous dynamo-electric machines. (8/2/19.)
140,561 Bygrave. Intercommunication telephone system. (19/2/19.)
140,563 Harris. Electrolytic cell. (21/2/19.)
140,568 Jones & Alloy Welding Processes, Ltd. Electrodes and welding and like rods used in soldering and depositing metals. (26/2/19.)
140,582 Goldstone & Farrell. Electric lamps for cycles and the like. (12/3/19.)
140,607 Damey & Damey. Electric switches. (8/4/19.)
140,629 Runbaken. High-tension magnetos. (25/4/19.)

Companies' Reports, &c.

The directors of Doulton & Company, Ltd., have paid a dividend of 5 per cent. (less tax) on the preference shares for the year 1918.

A quarterly dividend of 1¾ per cent. has been declared by the Electrical Utilities Corporation, Ltd., on the preferred stock for the quarter ended March 31.

The Submarine Cables Trust publishes in another column the numbers of certificates of the Trust which were drawn on the 3rd inst. for payment out of surplus income.

A dividend of 4 per cent. has been declared on the preference shares of the South Staffordshire Tramways Company for the past year and £863 has been carried forward.

The directors of the City of Buenos Ayres Tramways (1904), Ltd., have declared a dividend of 1s. 3d. per share, being at rate of 5 per cent. per annum for the three months ended March 31 last.

At an extraordinary general meeting of the Lanarkshire Tramways Company, last week, resolutions were passed increasing the number of directors to six, and appointing Mr. James Cullen Pollock a director.

The accounts of the Tucuman Tramways, Light & Power Company, Ltd., for the year ended June 30, 1919, show a profit of £421, which reduces the debit balance to be carried forward to £61,141.

The directors of Fellows Magneto Company, Ltd., have declared a dividend for the year of 25 per cent. and a participating dividend of 1½ per cent. on the 8 per cent. preference shares, making 9½ per cent. thereon for the year.

The net profit of the Para Telephone Company for 1919 was £11,753 and with £3,208 brought forward, the total is £14,961. The directors recommend a further dividend of 4 per cent., making 10 per cent. for the year, carrying forward £6,426.

The Melbourne Electric Supply Company, Ltd., have declared an interim dividend on the consolidated ordinary stock at rate of 10 per cent. per annum (5 per cent. actual), tax free, in respect of the half-year ended Feb. 29 last.

The directors of the Adelaide Electric Supply Company, Ltd., have declared an interim dividend on the ordinary shares at rate of 10 per cent. per annum (5 per cent. actual), tax free, in respect of the half-year ended Feb. 29 last.

In reference to the scheme of the Constantinople Telephone Company for providing for the funding of the arrears of interest on the obligations and debts due to contractors and others, the Inland Revenue authorities, taking into account the war conditions, have agreed that the income tax shall be at the rate of 4s. 6d. instead of 6s. in the £.

Holders of the 5 per cent. first debenture stock of the Ceara Tramway, Light & Power Company have been informed that, owing to the rise in the Brazilian exchange and the improved prospects of the company, the temporary reduction in the rate of interest will be terminated, and interest falling due on June 1 next will be made at the full rate.

The directors of the Oriental Telephone & Electric Company, Ltd., recommend the following final dividends for the year ended Dec. 31 last: 3 per cent. on the preference shares (less tax), making a total of 6 per cent. for the year; 6 per cent. on the ordinary shares (tax free), making a total of 10 per cent. for the year; and also a bonus of 2 per cent. on the ordinary shares.

The net profit of the Craigpark Electric Cable Company, Ltd., for the year ended March 31 was £17,454 (after making provision for excess profits and corporation taxes), which, with £1,560 brought forward, makes £19,014. The directors propose to appropriate £3,000 for depreciation of buildings and machinery, and £5,000 for reserve. The year's dividend on the 6 per cent. preference shares will absorb £2,850, and it is proposed to pay a dividend on the ordinary shares at 12½ per cent. for the year (£4,687. 10s.) and to carry forward £3,476.

The revenue of the Bristol Tramways & Carriage Company for the year 1919 was £848,050, against £749,872; expenses and renewals, £772,430, leaving net revenue £90,320 (including £14,699 brought forward). A final dividend on the ordinary shares at the rate of 4 per cent. per annum (tax free) is recommended, making 7 per cent. for the year, the carry forward being £32,258. Receipts of tramways department show an increase of £56,992, and the number of passengers carried on cars and motor-omnibuses was 72,838,076, compared with 61,813,124.

The capital expended by the Chiswick Electricity Supply Corporation, Ltd., during 1919 was £1,988, but £1,039 was written off plant for depreciation and £699 off the value of the free wiring on consumer's premises at Chiswick and Aberystwyth. After paying sinking fund premium and trustees' fees, the profit was £10,718. Interest on first mortgage debenture stock (£3,485) has been paid, and with the amount brought forward the sum available is £7,918. The directors recommend a dividend of 7½ per cent., that £2,000 be carried to depreciation reserve, and £1,208 be carried forward.

The accounts of the Indian Electric Supply & Traction Company, Ltd., for 1919 show a surplus in Cawnpore of £27,933 (against £19,271 in 1918). After meeting London expenditure and providing £3,796 for debenture interest there is a profit of £22,137, and with amount from last year (£1,171) £23,308 is available for disposal. The board have placed to reserve for depreciation and renewals £6,000; to general reserve, £2,500; and to debenture issue expenses, written off, £2,500, and they recommend a final dividend of 6 per cent. (making a total dstribution of 9 per cent. for the year), carrying forward £3,803.

The gross operating revenue of the Western Union Telegraph Company for 1919 (from the operation of the land lines for the last five months of the year, and from the cable system and the maritime provinces for the year) was $56,308,639. Operating expenses (including repairs, reserve for depreciation, rent, taxes, &c.) were $48,460,865, leaving $6,847,773, which, with compensation due from the U.S. Government for use of land lines from Jan. 1 to July 31 ($5,194,297) and income from loans and investments ($1,606,523) makes $13,638,595. Interest on bonds absorbed $554,937; amounts transferred to reserves, accrued depreciation, cables, $1,825,000, and depreciation of securities $623,271, leaving balance transferred to surplus account $10,635,386, which, with $82,518,993 surplus at Dec. 31, 1918, makes $43,151,380. Dividends paid (7 per cent.) absorbed $6,982,472, retroactive compensation to employees (1918) $985,387 and other surplus adjustments $471,051, leaving a surplus of $34,715,470.

It is announced by Mr. D. Sinclair, vice-chairman of the International Automatic Telephone Company, Ltd., of London, and managing director of its subsidiary, the Automatic Telephone Manufacturing Company, of Liverpool, that the new International Company is vigorously prosecuting the introduction of automatic telephone equipment in foreign fields and has received substantial overseas orders. Arrangements have been made by which the Western Electric Company, of London, undertake under licence the distribution of Strowger automatic equipment as manufactured at Liverpool in certain territory outside of the United Kingdom and outside of the territory controlled by the International Telephone Sales and Engineering Corporation of New York and its subsidiary the Automatic Electric Company of Chicago, and also outside of territory covered by the licences given by the Automatic Company to the Thomson-Houston of Paris. A substantial amount of new capital has been arranged by the new International Company for the extension of the plant of the Automatic Company of Liverpool, and it is expected that the manufacture of automatics on a large scale will be carried on there. The International Automatic Company is controlled by an International Syndicate composed of people who have been active in the management of the Automatic Telephone Company of Liverpool and Theodore Gary & Company Syndicate of Kansas City, who control the International Telephone Sales & Engineering Corporation of New York and the Automatic Electric Company of Chicago. Among the International Syndicate members are Mr. James Taylor and Mr. D. Sinclair, well known in connection with British manufacturing interests, and Theodore Gary, A. F. Adams and H. L. Gary, who have been for many years prominently connected with large independent exchange and long-distance telephone properties in the United States. The Liverpool organisation remains unchanged and the manufacture will proceed on the same lines as formerly, but the new arrangement will enable customers to benefit from quantity production of automatic equipment.

The profit of Johnson & Phillips, Ltd., for the year 1919, after making provision for bad and doubtful debts, and after charging to revenue upwards of £27,000 for maintenance of buildings, plant, &c., was £89,965. Adding £38,832 from 1918, and deducting dividend paid in May, 1919 (£17,500), and bonus of 1 per cent. on 1st mortgage debenture stock, the balance is £110,475. After paying remuneration of directors, &c., interest on debenture stock, second debentures, loans, &c., placing £12,198 to depreciation on machinery and plant, &c., and paying income tax and excess profits duty, the balance is £63,795. The directors recommend payment of a dividend at the rate of 12½ per cent. per annum on the ordinary shares (£30,625), leaving to be carried forward £33,170.

Mr. W. Claude Johnson, who presided over the annual meeting on the 29th ult., moved the adoption of the report. In the course of his analysis of the acounts he stated that £53,581 was expended during the year on additions to buildings and plant. The stocks and work in progress showed an increase over the preceding year of £130,000. The profit on the year might be considered very satisfactory, although it was not as great as had been anticipated, due to the difficultics in changing over from war work to ordinary commercial business, and particularly to the enormous trouble in obtaining the necessary raw materials. The orders booked during the current year far exceeded anything that they had had to deal with in the past. The orders in hand for the Post Office alone at one time totalled well over £250,000. Their foreign business had also increased very satisfactorily and included some important orders not only for Europe, but also for Japan and the United States of America. That increase in business was expected by the directors, and it was for that reason that they had made such extensive additions to the buildings and plant. Unfortunately those extensions had taken a great deal longer to complete than was anticipated, owing to the shortage in steel works and building materials and also to the strike in the foundry trade. If they had been completed by the contract time they could have given employment to many more workpeople and increased their turnover. The extensions were now nearing completion, some of the new buildings and plant had been in working order for two or three months.

The report and accounts were then adopted, a dividend of 12½ per cent. was declared on the ordinary shares (against 10 per cent. in 1918), and it was decided to increase the capital from £350,000 to £700,000 by the creation of 350,000 new ordinary shares of £1 each. Mr. John Macgregor (Managing Director), who seconded the resolution, said the extensions of the works and the increased business being done, entailed further capital outlay. They had a great deal more work offered than they could do, both for home and foreign markets. They had the buildings and machinery the staff and everything ready to do the business, but they had not sufficient money to tackle the ever-increasing business offered. It was not proposed to issue all their new shares at present; they desired to go cautiously, and only 87,500 shares would be offered at par.

Indo-European Meeting

Mr. J. Herbert Tritton, who presided over the ordinary general meeting of the Indo-European Telegraph Company, Ltd., last week, made a long and interesting statement as to the situation in Russia. He said that the one great need of Russia was economic, and foremost among all that that word connoted were communications and transports. The recognition of that fact was so universal and so pressing that the telegraph system must be one of the first cares of the authorities everywhere. The question that had chiefly engaged the attention of the directors was the re-establishment of the Indo route. After careful consideration they came to the conclusion that the interests of the company would be best served by the retention of the portion of the route traversing Germany. They had to look at the matter solely from the point of view of providing the most efficient telegraph line possible, and there could be no doubt that the German section fulfilled that requirement. They had, therefore, entered into negotiations with the German Government, and had agreed with them the heads of a satisfactory concession. They were indebted to their managing director (Mr. Stratford-Andrews), who proceeded to Berlin and Warsaw and conducted the negotiations. On the route of their old line the Poland of the Peace Treaty extended farther west than it did into Prussia and a good deal farther east into Russia ; negotiations with the Polish Government for a concession were in progress, and should offer no difficulty. The portion of the new Russia traversed by the route extended from Rowno to the Persian frontier : it was now under many governments, each of which was claiming separate political control. Odessa was one of their most important stations, not only as a junction, but as the one through which the maintenance of the whole of their Russian section was kept supplied. They were hoping to reoccupy the station before long. East of Odessa they anticipated no difficulty in agreeing terms with the young and vigorous nationalities that had arisen as a consequence of the war. The directors, who had long felt the great desirability of providing an alternative section to that through the Caucasus, had initiated negotiations with that object. Their Persian concession and communications remained undisturbed as to the restoration of the route their difficulties began east of Poland. Between Poland and Odessa much of the country had been fought over ; the same remark applied to a good deal of the line in the Caucasus. In neither case was there any serious difficulty once the necessary material was on the spot. They had concentrated the necessary staff at Odessa, and had provided a great deal of the material in anticipation of reopening the line this spring, when it became necessary to evacuate Odessa. The material would be found as near that place as practicable.

Referring to the financial side, Mr. Tritton explained that they were again unable to present accounts. The war disorganised all communications, particularly postal ones, and accounts, which might have been posted years since, had sometimes reached them a few weeks ago, and in many cases were still untraceable. As soon as they were able to reorganise matters they would present the long-waited statements. The war had disorganised their traffic, but the shareholders would receive an undiminished dividend, which had been made possible by the fact that not only had the finances of the company been well ordered, but they were able to carry local traffic on some of their sections. Their equalisation of dividends fund, before the declaration of the dividend, only sufficed to pay one more dividend at the rate of 6 per cent. per annum. If there were definite prospects of restoring their route this summer the whole 6 per cent. might have been now distributed, but the directors thought it wise to recommend a distribution of 3 per cent. only. In addition, there was the question of their Russian assets, amounting to over £140,000. None of the items were exceptional, apart from £93,000 due by the Russian Government. It was exceedingly difficult to estimate the value of Russian assets. To write them off as worthless would be a drastic proceeding. They had a reserve fund of £210,000 to fulfil the very purpose of meeting emergencies of that kind, and the directors intended to leave the valuation of the Russian assets in abeyance until the political position had defined itself more clearly. Even treating the Russian assets as valueless, the remainder showed a handsome surplus over capital and all liabilities. The lease of their premises expired in 1924, and they had secured the freehold of a house in Crosby-square, which would give room for expansion when required.

New Companies.

AMALGAMATED FIRMS, LTD. (166,503)—Reg. April 16, capital £200,000 in £1 shares, to carry on the business of electricians, accumulator manufacturers, manufacturers of electrical appliances, engineers, &c. Solicitor : E. C. Simmons, 18, Finch-lane, E.C.

THE COVENTRY AUTOMATIC TELEPHONES, LTD. was registered as a private limited liability company on the 23rd ult., with a capital of £60,000 in 6½ per cent. (tax free) preference shares of £1 each, for the purpose of promoting the use of and designing, installing and equipping automatic telephone exchanges, and manufacturing and supplying machine switching telephone apparatus. The directors are Messrs. M. S. Conner, James Fraser and H. P. Wells (British subjects), and F.R. McBerty and Kempster B. Miller (of Ohio, U.S.A.). The secretary and reg. office are : P. P. Kipping, 71a, Queen Victoria-street, London, E.C. 4.

E. B. C. ELECTRICAL COMPANY, LTD. (166,347).—Private company. Reg. April 13, capital £70,000 in £1 shares (20,000 preference), to carry on the business of manufacturers of and dealers in electric lighting and starting sets and accessories, &c., and to enter into an agreement with S. L. Price. First directors are : S. L. Price, L. C. Harvey, W. H. Carey and C. A. M. Buckley. Reg. office : 62, Eagle-street, W.C.

ELECTRICAL APPLIANCES (BLACKPOOL), LTD. (165,883).—Private company. Reg. March 29, capital £5,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, &c. First directors are : E. Jones, W. Outhwaite, T. S. Jones and A. Mortimer. Reg. office : 1, South King-street, Blackpool.

FRANKLIN ENGINEERING COMPANY, LTD. (166,122)—Reg. April 7, capital £50,000 in £1 shares, to take over the business of an electrical, mechanical and motor engineer, carried on by W. H. Franklin, and the business of a bioscope and scientific instrument maker carried on by T. W. Franklin. First directors are P. Evans, H. G. D. Cory, F. O. Cory, R. E. Duck, W. H. Franklin and T. W. Franklin. Sec. : A. D. Jones. Reg. office : 233, Cowbridge-road, Cardiff.

H. T. HAZZLEDINE, LTD. (166,208).—Private company. Reg. April 9, capital £10,000 in £1 shares, to carry on the business of electrical engineers and contractors, manufacturers of and dealers in electrical apparatus, &c. First directors are : H. T. Hazzledine and J. T. H. Barwood. Reg. office : 5, Talbot-street, Nottingham.

INCLEDON & LAMBERTS, LTD. (165,697)—Reg. March 25, capital £400,000 in £1 shares (100,000 7½ per cent. cumulative preference), to carry on the business of manufacturers of and dealers in iron or steel tubes and fittings, copper, brass, iron and other metals, &c., and to adopt an agreement with the shareholders of H. Incledon & Company and aambert Bros. (Walsall). First directors are W. B. and A. K. Incledon.

INTERNATIONAL INVENTIONS AND PATENTS EXPLOITATION COMPANY, LTD (165,698).—Private company. Reg. March 25, capital £1,000 in £1 shares, to carry on the business indicated by the title, and to adopt an agreement with M. Monot. First directors are : M. Monot, C. S. Hawkins and P. G. P. McCulloch. Reg. office : 5, New court, Lincoln's Inn, W.C.

JOHNS, BROWN, LTD. (165,891).—Private company. Reg. March 30, capital £20,000 in £1 shares, to carry on the business of builders and general ironmongers, electrical and general engineers, &c. Secretary : D. J. Weaver. Reg. office : 20, Oxford-street, Swansea.

PRECISION INSTRUMENT COMPANY, LTD. (165,516).—Private company ; reg. March 20, capital £5,000 in £1 shares, to carry on business ndicated by title. First directors are E. W. Smith, E. A. Petithory and F. C. Harding. Secretary, R. E. Petithory. Reg. office, 25 and 27, London-road, Forest Hill, S.E.

PREMIER ELECTRIC WELDING COMPANY (MERSEY), LTD. (165,602).—Private company. Reg. March 23, capital £60,000 in £1 shares, to acquire from the Premier Electric Welding Company, Ltd. ("Parent" Company) the business of the Parent Company as carried on in and near Liverpool, and to carry on the business of welders of metals, &c., but not to acquire the patents or patent rights of the Parent Company.

PREMIER ELECTRIC WELDING COMPANY (SWANSEA), LTD. (166,482) Private company.—Reg. April 14, capital £20,000 in £1 shares, to carry on the business indicated by the title. Solicitors : Bircham & Company, 46, Parliament-street, S.W.

SPANISH & GENERAL CORPORATION, LTD. (166,683)—Reg. April 19, capital £500,000 in £1 shares, to take over the business of the Spanish & General Wireless Trust, Ltd. First directors are Godfrey C. Isaacs, Alfonso Marconi, Capt. M. H. P. R. Sankey, S. F. St. J. Steadman. Sec. : H. W. Corby. Reg. office : Marconi House, Strand, W.C.

Prices of Metals, Chemicals, &c.

Tuesday, May 4.

		Price.	Ino.	Dec.
Copper—				
Best selected.........	per ton	£110 0 0	—	—
Electro Wirebars...	,,	£114 0 0	£1 0 0	—
H.C. wire basis......	per lb.	1s. 3¾d.	⅛d.	—
Sheet	,,	1s. 5½d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8¾d.	⅛d.	—
Brass 60/40—				
Rod, basis	,,	0s. 11¼d.	—	⅛d.
Sheet, basis	,,	1s. 4¼d.	—	½d.
Wire, basis	,,	1s. 3¾d.	—	—
Iron—				
Cleveland Warrants	per ton	£10 7 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£48 10 0	—	—
Lead Pig—				
English	,,	£42 0 0	—	£0 10 0
Foreign or colonial	,,	40 0 0	—	£0 10 0
Tin—Ingot	,,	345 10 0	—	£1 15 0
Wire, basis	per lb.	0 4 3½	1½d.	—

Salammoniac.—Per cwt. 105s.–100s.

Sulphur (Flowers).—Per ton £22.

,, (Roll Brimstone).—Per ton £22.

Sulphuric Acid (Pyrites, 168°).—Per ton, £8 8s. 9d.

Copper Sulphate.—Per ton £47.

Boric Acid (Crystals)—Per ton £74

Carbon Bisulphide.—Per ton £60.

Sodium Bichromate.—Per lb. 9d.

Sodium Chlorate—Per lb. 5½d.

Rubber.—Para fine, 2s. 2¾d. ; plantation 1st. latex 2s. 3d. lb

Shellac.—T.N. Orange, 550s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co.

Forty Years Ago.

(The Electrician, May 8, 1880.)

The Telegraph Construction and Maintenance Company.—We notice that a gold medal has been awarded to this company for their excellent show of cables at the Sydney Exhibition.

The Society of Telegraph Engineers. The next meeting will be held at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W., on Wednesday, May 12, when C. W. Siemens, D.C.L., F.R.S., past president, will read a Paper "On the Use of the Dynamo-electric Current in Horticulture and in Metallurgy."

Simple Apparatus for showing Electrolysis of Water.—A glass bolthead of 30 oz. or 40 oz. capacity is stopped with an india-rubber cork carrying two glass tubes, which contain hermetically-sealed platinum wires projecting an inch at the inner end, and terminating in binding screws at the other. The vessel is filled one-fifth full of acidulated water, boiled, and the stopper inserted to cause a vacuum when cold. On connecting with two "Grove" cells, the bubbles of gas so expand as to make the whole liquid appear to boil. With either a single "Grove," "Bunsen," "Bichromate," or "Leclanché" cell continuous decomposition may be obtained. When sufficient gas has collected to impair the vacuum, it may be restored by boiling.

An Electric Furnace.—Dr. C. W. Siemens has experimented for some time with an electric furnace for the purpose of melting, in considerable quantities, highly refractory metals, such as platinum, iridium and steel. In a small one recently exhibited before the Royal Society the positive electrode, which was made of iron, entered from below the crucible containing the metal to be melted, the negative electrode (a rod of carbon) was attached to a lever to a solenoid regulator. The crucible was surrounded by charcoal contained in a copper vessel to prevent loss of heat and the intense heat obtained from the electric current melted 2 lb. of broken files in 20 minutes. The arrangement may easily be applied on a large scale; and electric fusion has, it is claimed, the advantage of excluding the atmosphere and the products of combustion from the substance in the crucible. But how about the volatilised carbon from the electrode.

Extracts from the Leader on "City and Guilds of London Institute."—Prof. Ayrton says, "By a technical school I understand not one in which the manipulation or routine of a trade is taught, but a school where a lad receives *general* instruction in the principles of applied science, and *special* instruction in the application of these principles to the particular trade he is following or about to follow." . . . The City and Guilds Institute undoubtedly accepts this general idea. Regular instruction has commenced. In connection with the Cowper-street Schools, pending the building of special laboratories, the professional lectures and tutorial supervision are carried on. . . . The day classes will specially cater for the scientific requirements of persons partially engaged, or intending to engage, in the manufacturing industries. Amongst other things named we notice that Prof. Ayrton is to give a special laboratory and tutorial course in electrical engineering.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics":—"Running Costs"; Lecture by Captain Liptnot on "Radiators" (conclusion); and "Loads and Stresses in Aeroplanes," by John Case.

"Cabinet Maker":—"Colour and Form," by M. McLeish; "A Plea for the Use of Tapestries as Domestic Wall Decorations"; and "Modernising Old Designs in the Upholstering Shop."

"Chemical Age":—"Nitrogen Fixation Installations in England"; "Fire Dangers in Factories and their Causes (II.)"; and "Dr. Stephen Miall on Atomic Weights."

"The Fruit-Grower":—"Apple Packing on Co-operative Lines," by Duncombe Gibbs; "Health Week: An Omission"; and "Popularising the English Apple."

"The Gas World":—"Gas Heating in Relation to Economy in Building"; "The Coal Smoke Curse," by Dr. Saleeby; and the South Metropolitan Gas Company's Bill before a House of Lords Committee.

"Hardware Trade Journal":—Next week's I.F.A. Conference: What to See in York; "Handling Furnishing Hardware"; and "Mass Production in Machine Tool Manufacture."

"Ways and Means":—The Political Outlook in Germany, by Captain Wedgwood Benn, D.S.O., D.F.C., M.P.; "The Welwyn Garden City," by Captain R. L. Reiss; and "Business Openings for Capital," by F. W. Raffety.

The Editorial, Advertisement and Publishing Offices of "The Electrician" *are at* 8, *Bouverie Street, London, E.C.4. Telegrams: Benbrotric, Fleet, London. Telephone: City* 9853 (4 *lines*).

The subscription to "The Electrician" *is* £2. 12. 0. *per annum in the United Kingdom, and* £2. 14. 0. *per annum Abroad. Advertisement Rates can be obtained on application to the Manager. Advertisement copy and blocks should be received on the Friday preceding date of publication*

Arrangements for the Week.

FRIDAY, May 7th (to-day).

Iron and Steel Institute.

10 a.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Papers to be read on "Direct Current Compared with Three-phase Current for Driving Steel Works Plant," by Mr. C. A. Ablett; "Notes on Slag Conditions in Open Hearth Basic Steel-making Practice," by Mr. J. F. Wilson; and "The Reduction of Silicon from the Slag in the Acid Open-hearth Process," by Messrs. B. Yaneske and G. A. Wood.

2.30 p.m. "Some Defects in Electro-deposited Iron," by Mr. W. E. Hughes; "Note on the Ball Test," by Messrs. T. Baker and T. F. Russell; "The Distribution of Phosphorus in Steel between points Ac 1 and Ac 3," by Mr. J. H. Whiteley; and "Practical Notes on the Design and Treatment of Steel Castings," by Mr. G. F. Preston.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Pulverised Fuel," by Mr. J. G. McBryde.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "The Blue Sky and the Optical Properties of the Air," by the Right Hon. Lord Rayleigh, F.R.S.

SATURDAY, May 8th.

Association of Engineers-in-Charge.

6 p.m. At the Holborn Restaurant, London, W.C. Twentieth Annual Dinner.

TUESDAY, May 11th.

Institution of Electrical Engineers, North Midland Centre.

7 p.m. At Hotel Metropole, Leeds. Annual General Meeting.

Illuminating Engineering Society.

8.15 p.m. At the Royal Society of Arts, John-st., London, W. An Account of Recent Developments in Portable Types of Cinema Outfits will be delivered by Capt. J. W. Barber, C.B.E.

THURSDAY, May 13th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper to be read on "Permanent Magnets in Theory and Practice," by Mr. S. Evershed.

Institution of Automobile Engineers (Graduates' Section).

8 p.m. At 28, Victoria-street, London, S.W. Paper on "The Chemical and Physical Properties of Iron and Steel," by Mr. W. E. Benbow.

FRIDAY, May 14th.

Iron and Steel Institute.

3 p.m. At Mappin Hall, The University, Sheffield. Papers to be read: "Effect of Initial Temperature upon the Physical Properties of Steel," by Messrs. J. H. Andrew, J. E. Rippon, C. P. Miller and A. Wragg; "The Properties of Iron-Chromium Carbon Steels. Part I., Thermal Analysis," by Messrs. C. A. Edwards, H. Sutton and G. Oshi; Part II., "Effect of Heat Treatment on Electrical Resistivity," by Messrs. C. A. Edwards and A. L. Norbury; "On the Structural Constitution, Hardening and Tempering of High-speed Steel containing Chromuim and Tungsten," by Messrs. K. Honda and T Murakami; "The Structure of some Chromium Steels," by Mr. J. H. G. Monypenny; "The Effect of Various Elements on the Electrical Resistivity of Iron," by Mr. A. L. Norbury; and "Brittleness of Nickel-Chrome and other Steels, Part II.," by Mr. F. Rogers.

Physical Society of London.

5 p.m. At the Imperial College of Science, Imperial Institute-road, South Kensington. Demonstration of Experiments on the Thermionic Properties of Hot Filaments, by Dr. F. Lloyd Hopwood. Papers: "A Modified Theory of the Crookes Radiometer," by Mr. G. D. West; "On the Magnetic Properties of Silicon-Iron (Stalloy) in Alternating Fields of Low Value," by Mr. A. Campbell; "On Tracing Rays through an Optical System," by Mr. T. Smith.

Institution of Electrical Engineers, Students' Meeting.

7 p.m. At King's College, Strand, London, W.C. Paper on "Electrical Motor Control Devices," by Mr. E. G. Humfress. Annual General Meeting.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Discussion on "Business Aspect of the Peace Treaty," opened by the Hon. H. Fletcher Moulton.

Institution of Automobile Engineers.

7.30 p.m. At the Technical Institute, Coventry. Paper to be read on "Cast Iron in Relation to the Automobile Industry," by Mr. J. E. Hurst.

THE ELECTRICIAN.

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,191. [Vol. LXXXIV. No. 20.] FRIDAY, MAY 14, 1920. PRICE ONE SHILLING. *By Post, 1s. 1d. Abroad 1s. 2d.*

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Notes.

Electric Furnace Development.

IN order of importance among the industries of this country iron and steel can only yield place to coal. The combination of the two has, it may be said without undue exaggeration, raised this country to its high position among the industrial nations of the world. The Iron and Steel Institute is the representative body of the technical side of that great industry, and the remarks of its president are therefore worth respect, especially when he happens to be so eminent a metallurgist as Dr. J. E. STEAD. Following a much-worn precedent, Dr. STEAD reviewed, in his presidential address, the progress of the ferrous industries within the last half century and referred particularly to the rapid development of the electric steel furnace. Before the war only a few electric furnaces were in use in this country, but since 1914 a large number of electric furnaces were erected in Sheffield and other parts of the country to deal with the enormous mass of shell borings produced. He pointed out electric furnaces had been largely used to replace crucible melting and had come to stay, for immense quantities of special alloy steel were now being made by their aid.

A Revolution of Thought.

THIS is indeed a change, and although we agree with Dr. STEAD, we may be permitted to wonder whether this opinion is held by the iron and steel masters as a whole. If it is generally held, then there has been a revolution of thought in the short space of six years. It is certainly little more than that time ago that we were being told that the electric furnace could have very restricted application, and that its use would be mainly in the manufacture of special steels of which only small quantities were required. The fact is that iron and steel manufacturers, the progressive ones at any rate, are finding that more precise methods pay. That it is no longer advisable for the mixing and operating temperature to be left to a furnaceman working from experience based on a curious blend of facts and superstition, but that every operation must be controlled and that the best methods are those about which the most is known, so that the same results can be unfailingly obtained time after time.

The Electricity (Supply) Bill.

OPPOSITION is already organising against the Electricity (Supply) Bill. At a recent meeting of the Electrical and Allied Trades Section of the London Chamber of Commerce the measure was stigmatised as a serious discouragement to enterprise and a development of State trading. It was, therefore, considered that the Electricity Commissioners should have time to test the sufficiency of the 1919 Act before any further legislation was passed. We agree that nationalisation, in the ordinary accepted meaning of the term, is a failure; but we do not think that the Bill spells nationalisation. The present Act is all very well, but it leaves the Commissioners no powers to push their ideas home, not against the progressives who are the majority, but against the reactionaries, who, though in the minority, may prove as awkward to deal with as the man who, owning a small plot of land contiguous to a large estate, is able to hold up a scheme of building which would confer general benefit. The new Bill is surely not a case for out-and-out opposition, but for compromise, and compromise means that both sides give way. Much of the finance of the Bill is predatory, no doubt, but of the rest there is little to complain.

An Old Controversy.

IT is a pity that Mr. C. A. ABLETT's Paper on "Direct Current Compared with Three-Phase Current for Driving Steel-Works Plant" was read before the Iron and Steel Institute and not before the Institution of Electrical Engineers. It deals with two subjects upon which a good discussion is always possible, because there is general disagreement about them. The first of these is sufficiently indicated by the title of the Paper. Mr. ABLETT is an out-and-out direct current enthusiast. Direct-current motors are the most efficient, fulfil the torque requirements more closely and give better speed regulation, whether they be applied to driving merchant and bar mills, sheet and tin-plate mills, wire mills, tube mills, reversing rolling mills, or live roller gear. In coming to this conclusion Mr. ABLETT is likely to be supported by all but the very biased upholder of three-phase working. But when he goes a step further and comes very near to recommending the use of high-speed turbines driving a slow-speed continuous-current dynamo through helical gearing, the support will not be so certain. To use such a machine means a greater first cost than when the more usual three-phase alternator is employed. At the same time it does away with the necessity of installing motor generators or rotary converters, and thereby not only saves the first cost of those items but their subsequent labour and running charges. Here again finance is the deciding factor, though local conditions may have some influence, and at present our experience of geared turbines is hardly sufficient for their universal employment to be recommended.

The Case Against " Linking Up."

The second question which Mr. Ablett discusses is the desirability of linking up an iron or steel works with the public supply to provide a stand-by to the works powerhouse, or alternatively of providing the supply authority with the surplus power from the works. The way in which he does it is most surprising. " It is evident," he says, " that if a power supply authority undertakes to provide a stand-by of, say, 1,000 kw., it must invest capital in an additional 1,000 kw. of plant and keep this plant as a stand-by to supply on demand whether it is demanded or not." To see whether this is being done the works owner should demand the stand by supply unexpectedly from time to time. This is quite fallacious. We agree with Mr. Ablett that the stand-by supply is an insurance. But for every life insured for £1,000 an insurance company does not add £1,000 to their reserve fund, nor does the policy holder think it necessary to realise his policy from time to time to see if the money is there. It is true that if all the policy holders died simultaneously most insurance companies would be in Queer Street, and so would any electricity supply authority if every consumer made his maximum demand at the same time. But such a thing is so improbable that it is not worth insuring against.

Connections and Plant Installed.

If Mr. Ablett will examine The Electrician Annual Tables of Electricity Supply he will find in most cases that the total load connected exceeds the total capacity of the generating plant, but there is no danger in this. Mr. Ablett's argument is not only fallacious, it is unwise. The waste gases available in a modern iron and steel works are not alone sufficient to generate the electrical energy required in those works. But the necessary " make-up " is better supplied from a public authority, not only because it is cheaper to do this but because it is the business of the iron and steel maker to produce iron and steel, not electrical energy. As our description of the Warrenby Steel Works shows, this is the practice followed in the most up-to-date mills.

Excess Profits and Economy.

The excess profits tax is apparently to stand at the new figure, at any rate for this year, and, together with the new Corporations Tax, will form a heavy drag on industry, however it may relieve the burdens of the Chancellor of the Exchequer. It is true some unwilling modifications may be obtained in the debate on the second reading or in Committee, but we fear that the opposition, though weighty enough in the country, is hardly sufficiently organised in the House of Commons for anything much to be done. The joint deputation of the Association of the British Chambers of Commerce and the Federation of British Industries, which waited on Mr. Austen Chamberlain with regard to this matter, was received with sympathy, but went away with little more than a promise that certain inequalities and injustices should be corrected. The deputation's proposal that a fairly high profits tax should take the place of the present duty would not, had it been accepted, have been received with universal approbation, even by members of the Association, though it is certainly better than a capital levy, and fairer in its incidence than the excess profits duty. It is really a choice of evils. Money is required for the liquidation of our war commitments, and some means of raising it must be found. This being so, we should like to see more stress laid, both in the country and in the House of Commons, on the need for economy in Government expenditure. If money is raised only to be wasted, disaster must result. Yet that is what is happening at present.

A Milestone in Industrial History.

A resolution recently adopted by the Home Counties Industrial Council for the Electricity Supply Industry forms a new and most important feature in the procedure of such councils, and may have far-reaching results. By this resolution the Council seems to approve of the Trades Unions employing strikes to enforce its decisions. In fact, it goes further, and supports the Trades Unions in such action. These District Councils are of a quasi-official character. They have practically been created by Government, and are empowered to deal with nearly every question that may arise between employer and employee. If, therefore, a Trades Union calls out the men in a dispute of this kind, the men will be obeying, not merely their unions, but the Industrial Council, acting for the Government. This would be quite a new sort of strike. No assistance could be safely given by the staffs of any other undertaking, for any man assisting to break the strike would be pitting himself, not only against his union, but against all the employers represented on the Council.

Liability to Consumers.

There is the further question of the liability of any undertaking to its consumers, should it risk a cessation of supply by a strike of this nature. Would a plea of *force majeure* stand if strikes are constitutionalised, so to speak, by the express approval of the District Council ? This action has been brought about by the uncertainty as to whether undertakings must follow the recommendations of the Industrial Councils. There is, of course, no legal force behind these resolutions. The only force is a moral one. But when this moral force, in any particular case, is ignored the Council is placed in a dilemma. It must either confess that it cannot legislate for the area under its control, or it must devise some coercive means of getting its recommendations put into force. The Home Counties Council has taken the bull by the horns. Its action will precipitate matters, and we shall await the result with interest.

Coal Prices Up.

As we foreshadowed last week, coal prices are up. The effect is at one fell swoop to submerge the 10s. rebate on domestic fuel supplies and to add 4s. 2d. to the charges for industrial coal. The official reason for this is that exports have been diminishing in face of the ever-growing home demand, and that the subsidy obtained from the high prices in that market has correspondingly decreased. Wages have also risen, and are said to be accountable for 2s. 10d. of the increase. Such a large increase in price cannot be without its retarding effect on the recovery of our industries. The prices of everything must rise from bread to castings. Not the least of the bad effects, from our point of view, will be its influence on the paper market, where conditions are already such as to give rise to the greatest anxiety. One bright spot is that control is to be removed. Of all the controllers, the Coal Controller has been the least satisfactory. The consumer will now be able to buy where and what he likes, and we shall no more hear of such examples of official ineptitude as the diversion of coal on rail for Manchester to some other town, leaving the electricity works in the former, not only without proper reserves, but with hardly enough for immediate needs. That is something to be thankful for. Another bright spot is that station engineers will no longer have to worry about working out the rebate.

Lighting in the Central Station.

In view of the fact that the main purpose of most electric supply companies is to produce energy for lighting purposes, it is a curious anomaly that we not infrequently find the lighting of the station itself has received little care. In some cases the illumination is actually insufficient, either showing misplaced economy that argues a singular lack of proportion or a want of recognition of the effect of inadequate lighting on safety and efficiency. An American contemporary remarks in this connection that it was formerly a common practice for old carbon filament lamps to be stored for use in the station "since income was not at stake!" In other cases the lamps are plentiful, but the outlets are located without due consideration of the purpose to be served by the light, so that the lamps give rise to inconvenient glare or throw plant and machinery into deep shadow. Anyone who has had the experience of squeezing their body through a narrow ill-lighted space in close proximity to high-tension conductors will recognise the justice of these remarks. Illumination in a central station should play an important role in promoting safety, facilitating the inspection of instruments and supervision, and assisting in overhauling and repairs. In the first instance there should be a thoroughly adequate general illumination, with lamps mounted well above the direct range of vision, so as not to obstruct a clear view throughout the room, and to ensure safe motion of all operators round the machines. Specialised lighting for certain points should be added as experience demands. For example, the switchboard commonly requires special lighting, and the same applies to instruments, gauges, &c., in the boiler room, and to oil switches. Some degree of flexibility is desirable so that light can be conveyed to any point where work is being done. The pits under alternators are commonly unlighted, and operators entering them must introduce a portable lamp. But in some of the latest American stations and even in this country permanent illumination from lamps sunk in the walls of the pit, so arranged as to light up the parts without dazzling the eye of operators, have been installed. In the central station, as the source from which all energy proceeds, the conditions as regards lighting should be the best that can be contrived. There is room for as much ingenuity here as in any of the consumers' installations where the energy is used, and economy is of small moment in comparison with suitability of the lighting for the purpose in view.

Private Bill Legislation.

The private electricity supply bills of the present session are not of outstanding importance. The interesting scheme for the utilisation of the water-power on Dartmoor has been dropped, owing to local and national opposition; but we understand that it will be revived in a modified form next year. The majority of the remaining measures only seek extensions of the area of supply, or additional capital or other powers to enable the promoters to carry on their business on modern commercial lines. During the past week two of these bills have been rejected by Select Committees, mainly owing to the action of the Electricity Commissioners, who reported against the grant of the powers demanded. No doubt great weight should be given to the opinions of the Commissioners on all questions relating to the generation and distribution of electricity, matters in which standardisation is not only desirable but necessary in the interests both of the industry and of national progress. If, however, Committees take up the attitude that everything relating to electricity supply, including special powers required to meet exceptional circumstances, must have the approval of the Commissioners, then it will be useless for undertakers to promote bills for these subsidiary powers.

Special Powers and the Domestic Load.

The Commissioners' policy on this special powers question is not clear. A clause in the Swansea Bill to enable the Corporation to provide, fix, sell and let for hire motors and electric fittings was rejected because it was thought that clause 23 of the Electric (Supply) Act of 1919 (which enables authorities to provide, let for hire, repair and maintain, but not to manufacture or sell, electric lines, fittings, apparatus and appliances) was sufficient for the purpose. In our opinion, clause 23 is not wide enough to enable local authorities to carry on their undertakings on a proper commercial basis. In order to develop electric heating and cooking, and domestic supply generally, it is necessary to have the power to provide and let on hire motors, cooking and heating apparatus and other electrical appliances. It frequently happens that consumers who hire motors and fittings wish to purchase them after a short experiment, and anything which prevents local authorities from carrying out the sale is a clog upon progress. If local authorities cannot be entrusted with full powers to develop their electricity undertakings, then they should not be entrusted with authority to supply.

No Increase in the Maximum Price.

In the other case, Edmundson's Electricity Corporation and its associated companies sought authority to increase the maximum price of electricity to 1s. 2d. per unit, on the understanding that the dividend was limited to 6 per cent. until the charge was brought below 1s. a unit. The majority of the undertakings affected are in the provinces, and have never paid a dividend. They have been badly hit by the advances in wages, by the increasing price of coals and materials, by wartime restrictions and other causes. It is true that some of them have been allowed to increase their prices under the Statutory Undertakings (Temporary Increase of Charges) Act, but this has brought them little relief, and it is probable that if the Bill had been considered on its merits the companies would have obtained what they wanted. However, as the Electricity Commissioners had reported against the measure, it was rejected by the Select Committee of the House of Lords before whom it came. We should like to know the reason for this. Undoubtedly the case of these companies is a hard one, and we hope that the Commissioners or the Ministry of Transport will introduce suitable legislation to enable the various undertakings to pay a reasonable return on their capital.

Psychology and the Worker.

In a recent contribution to the gaiety of the nation, Mr. Keble Howard defies "the greatest electrician in the world to invent a club which will play a mashie shot of 80 yds. and leave the ball 2 ft. from the pin." Although the last thing we should think of doing with a humourist is to take his statements seriously, we may perhaps remark that Mr. Keble Howard's attitude towards invention is typical of that of the ordinary man in the street. That gentleman thinks something should be invented to help him to do difficult things, while the whole object of invention should be to provide machines to do things which require little or no brain effort, so as to leave that wonderful apparatus, the human organism, free to think out and train itself to perform really difficult actions. To extend Mr. Howard's illustration, machines should be invented to copy figures from ledgers into pass books, leaving the clerk who now performs that heart-breaking task free to practice kicking goals, an operation which requires a delicacy of touch, a judgment and an adaptation to varying conditions which no machine invented could ever hope to supply. This present tendency to turn a man into a machine, or, in other words, to train men to perform actions which machines could perform equally well, is a danger which must be strenuously fought against by all who want to see real improvement in the working conditions in industry. There is no doubt that, like a great many other commodities at the present time, labour is being wasted, and that one of the most urgent problems is to stop that waste. We are informed that an organisation known as the National Institute of Psychology and Physiology has been formed to consider such questions as industrial fatigue, the definition of tests and standards for the guidance of workers in the choice of an occupation, and to publish facts relating to these matters. Training courses for managers, foremen and welfare workers will also be held, as well as studies into conditions in various works, and of the psychological relations between employer, manager, foreman and worker, with special reference to securing harmony and co-operation. There is no doubt that such an Institution may do a great deal of good. Equally, it may do a good deal of harm. If tact could be taught, that would be the most important subject in the curriculum—a subject in which all foremen, and especially all welfare workers, should be obliged to obtain full marks. Seeing that it cannot be taught, the most important thing to realise is that the worker hates being mothered, and that the greatest improvement in output will be obtained by showing the worker that it is to his own advantage to take an interest in his work. Any Institution which works to that end is to be heartily encouraged.

Authority and Invention.

Mrs. Ayrton, in her pungent fashion, has been attacking the War Office for its neglect of the anti-gas fan designed by her. The history of the affair is probably well known to most of our readers. Early in 1915 Mrs. Ayrton discovered that hand fans of proper shape could drive away poisonous gases both quickly and effectively. But in the War Office view the apparatus was too simple to be efficient. Notwithstanding favourable reports from the man on the spot and pressure from the man at the back, it took over a year to get the fans accepted, and when they were accepted only very small numbers were issued accompanied by instructions for their use, which, to say the least of it, were misleading. This is what one expects from the War Office, and if its attitude towards enterprise changed there would be keen disappointment. But after all, absurd though it is, this attitude differs only in degree, and not in kind, from the general attitude towards invention in this country. We all have heard stories of manufacturers refusing to consider devices which have subsequently brought their rivals fortunes, and of publishers refusing poems whose music has later resounded throughout the world. Let us be fair—even to the War Office. The reason for their policy is not hard to find. It is largely due to the inventors themselves. Of every 100 inventions 95 are impossible for one reason or another, four are perhaps feasible and one may have money in it. In literature the percentage of obvious failures is higher still. If inventors would only invent things that would work and bring in money at once, and Government Departments would only employ people to examine inventions who knew something about them, then we might expect to see some improvement in the present distressing state of affairs.

The Resistivity of Iron and Steel.

Our knowledge of the properties of iron and steel is, indeed, becoming wider, partly due to the hard work and enterprise of our metallurgists and not a little due to the encouragement given to investigation by the iron and steel masters and by the Iron and Steel Institute itself. Two Papers on the electrical resistivity of iron and steel read at the Annual Meeting of the Iron and Steel Institute are an illustration of this. The first due to Prof. C. A. Edwards and Mr. A. L. Norbury gives an account of the experimental methods used and the results obtained in determining the electrical resistances of steel when in the annealed condition, when air and water quenched from different temperatures, and after tempering the various quenched specimens at progressively increasing temperatures. These experiments show some interesting results. In the annealed condition the effect of chromium is to raise the resistivity of iron by 3·75 michroms for each 1·0 per cent. in excess of 1·3 times the carbon content owing to a proportion of the excess remaining in solution with the iron. Below that figure the addition of chromium has little effect. So far as can be estimated the effect of chromium upon the resistivity of iron appears to be to cause an increase of about 5·1 michroms per cubic centimetre for the 1·0 per cent. held in solution. The reason for this is not yet clear.

Effects of Various Elements on Resistivity.

In another Paper due to Mr. Norbury alone it is pointed out that Benedick's method of plotting the resistivity value of quenched carbon steels on a straight line, and extrapolating to 7·6 michroms per cm. cube as the resistivity of pure iron can no longer be considered correct, as recent determinations give 9·9 michroms per cm. cube as the resistivity of pure iron at 20° C. It is also pointed out that equi-atomic quantities of different elements dissolved in iron do not increase the electrical resistivity to exactly the same amount, while a new factor depending on the electronic properties of the particular element in solution determines the atomic resistivity increase in each case. This factor appears to be closely related to the difference between the decomposition potentials of the solvent and solute. These may seem to be problems remote from the interests of the electrical engineer. But this is not the case. Iron and steel are so largely used in all branches of electrical engineering that any addition to our knowledge of its properties is both welcome and necessary. As an example we may mention the investigations that are now taking place into the magnetic properties of an iron alloy which may lead to a possible reduction in the amount and therefore the weight of iron required in magnetos, and probably also in larger sized generators. The time has gone by when practice and theory can be considered as being in any way opposed.

The Past and the Future.

To look through the volumes of any journal is at once amusing and depressing. Both the amusement and the depression are, however, accentuated when the journal is one in the production of which the searcher has been intimately concerned. Glancing at one page, he says, with Swift, "What genius I had then"; glancing at another, he cannot do other than call down silent derision upon himself as, blushing, he hurriedly turns the leaves. This is particularly the case when he has had the temerity to prophesy, and it was with something of the feeling that we have just described that we read in The Electrician for May 15, 1880, that a M. Penodie claims to have discovered a method of transmitting large quantities of electricity over long distances, and the editorial comment that this is too good to be true. We must admit that was one of the things better left unsaid, and we wonder whether the Editor of THE ELECTRICIAN in 1960 will think the same of remarks we are making to-day.

Engineers and English.

EVERY Frenchman can write French lucidly, accurately and with emphasis and point even if, like the celebrated M. JOURDAIN, he does it unconsciously. It is equally true that most Englishmen do not write well or, if they do, their efforts bear signs of strain which is generally associated with the propagation of jokes by Scotchmen. To this indictment engineers must plead guilty. They do not, it is true, write English quite so badly as a Government official, but still they write it pretty badly. Engineering and electricity are both intrinsically difficult subjects. The more necessary then that everything written about them should be composed with the utmost care so that the words used bear the meaning that they are intended to convey, and that each sentence and each paragraph developes the argument without a check or a false step. To employ an obscure style to explain an abstruse point is to throw a double burden on the reader; and is more suited to the philosopher than to the engineer. MEREDITH would have been an even greater genius had he been easier to understand, and as there is no room for that sort of genius in engineering, the more the engineer makes his style simple and clear the better English will he write and the greater benefit will he confer on those who have to read what he writes.

Water Power in the Colonies.

The development of their water power resources is as important for many of our great self-governing Dominions and smaller Colonies as it is for this country. They have the advantage that parts of the country are largely undeveloped. They are, therefore, in a position to start from the beginning. And while it is not to be supposed that every new town will be placed at the bottom of a waterfall, undoubtedly its site will be influenced by the ease with which it can obtain a supply of electric power at a small capital outlay. We are, therefore, not surprised to see that the whole problem is being very carefully considered in many widely separated parts of our Empire and that some very interesting schemes of development have been prepared.

SOME STATISTICS FROM CANADA.

In Canada the Water Power Branch of the Ministry of the Interior and the Bureau of Statistics of the Department of Trade have recently published a report containing some exhaustive analyses of the developed water power in that country. It is stated that the water power resources of the British Empire amount to from 50,000,000 H.P. to 70,000,000 H.P., of which total about 20,000,000 H.P. is in Canada. These figures are probably under-estimated, as no complete information can exist as to the extent, or even the presence, of the water power in some of the more remote Colonies. But in any event they show that there is a way in which the future large demands for electric power may be met.

In Canada some 2,215,000 H.P. of water power plant is now employed in useful work, and with plant under erection and construction this figure will be increased to 3,385,000 H.P. within a short time. Roughly 75 per cent. of this total is employed in the generation of electric energy and of the remainder nearly 500,000 H.P. is used in the paper industry.

A NETWORK OF TRANSMISSION SYSTEMS.

This enormous hydro-electric development is resulting in a network of transmission systems practically covering the central and south-west of Ontario and the south of Quebec. Indeed, no less than 91·4 per cent. of the electric power generated in the Dominion is generated by water power. And this is not by any means effected entirely by small units, for in the Province of Quebec there are six 20,000-H.P. units and two of a similar size in Ontario. There are also 68 units with capacities between 10,000 H.P. and 20,000 H.P., with a total horse power of 869,900, so that the hydraulic turbine is a rival to the steam turbine in size.

The water power resources of Canada, as the report says, form a substantial basis for progressive exploitation and an assurance of combined industrial prosperity. There seems no reason why this optimistic view should not be the correct one.

THE RESOURCES OF BRITISH GUIANA.

Turning from the north to the south of the American Continent an interesting preliminary report by Mr. STAFFORD COMBER on the possibility of development of the water powers of British Guiana for the generation of electrical energy has recently been published. The industries of the colony are established upon the coastal belt and the question has therefore been considered from the point of view of their requirements. The possibilities of developing three rivers, the Cuyuni, the Essequibo and the Demerara, were considered and the opinion is expressed that a total of about 800,000 H.P. could be obtained from them and that transmission to all the coast industries is a possibility at no great cost. At present the demands would total about 30,000 H.P., but this would doubtless increase rapidly when the advantage of electric lighting over oil lamps was realised. Such a development would also prevent the burning of bagasse to generate steam, as is done at present, and incidentally allow all this grass to be turned into paper which could be used both in the colony and advantageously exported. Hydro-electric power would also enable home manufactured instead of imported fertilisers to be used.

ELECTROLYTIC ZINC IN TASMANIA.

Two large hydro-electric schemes are also being carried out in Tasmania for the production of electrolytic zinc. The great lake at Risdon is being developed to supply 70,000 H.P. at an estimated cost of £2,500,000 for the Electrolytic Zinc Company's works, while similar operations have been begun at Lake Rolleston on the west coast of the Island for supplying the Mt. Read-Rosebury Company with power for the production of 50 tons of zinc per day. Woollen mills, white lead and ink making plants have also been attracted to the Island by the cheap power.

THE INDUSTRIAL FUTURE.

A consideration of all these enterprises may throw a little light on the future development of the industries of the world. It would seem that the tendency may be away from coal fields to the remoter regions of waterfalls, and that there will be a corresponding movement in favour of bright, cleaner and therefore more efficient manufacturing processes. It may also mean the gradual sinking into decay of those countries whose rise to fortune has been due to coalfields being discovered within their boundaries, and a rise in their turn of still newer countries where fortunes will be made from water.

Costing.

Some Phases of Modern Cost Finding with Particular Reference to the Manufacture of Electrical Apparatus.

By REGINALD TOWNSEND, A.C.A.
(Works Accountant, Metropolitan-Vickers Electrical Co., Manchester.)

(Concluded from page 495.)

Application of Factory Expense or on Cost to the Prime Cost of Particular Apparatus or Product.

In practice few difficulties present themselves in dealing with productive material and productive (or direct) labour. Productive material is usually drawn by stores requisition, or similar medium, and costed directly to the particular apparatus or product; and productive (or direct) labour can also be costed directly to the particular apparatus or product, through the workers' piece or day work tickets, production wages card, or similar medium.

The application or diffusion of factory expense to the cost account presents many more difficulties, and is well worth detailed consideration. There are various methods of applying factory expense to the cost of the particular apparatus or product, and before deciding which method may be adopted for any particular department or works, careful consideration should be given to all conditions surrounding the manufacture of such apparatus or product. The methods may be summarised as follows: (1) On List Percentage, or Process Plan; (2) New Pay Rate; (3) On Basis of Percentage of Factory Expense to Productive Labour and Productive Material; (4) On Basis of Percentage of Factory Expense to Productive Labour; (5) On Basis of Factory Expense to Productive Hours worked; (6) Machine Hour Basis, which may be divided into: (*a*) Old Machine Rate; (*b*) Fixed Machine Rate; (*c*) New Machine Rate.

On List Percentage or Process Plan.—By this method the charge for each element or operation is expressed on an arbitrary list price. The list selling price of the product is usually taken as its list percentage price. This method of costing is frequently applied to product manufactured under mass production, also where the product cannot conveniently be costed under its specific order number. This method lacks sensitiveness to cost variations, and can only be applied, with advantage, under special conditions.

New Pay Rate.—This method contemplates the addition of a percentage to the Productive Labour to cover the Factory Expense. The gross amount comprising these two items is then charged to the Cost Account as New Pay Rate.

On Basis of Factory Expense to Productive Labour and Productive Material.—The correctness of this method is based on the assumption that productive labour and material will retain their proportionate values. In practice seldom is this found to be the case, as apart from the variations which may be expected to arise from different rates of wages, a greater difference would occur in the price of material, such as wood and copper, from which it would follow that the job having the copper, or more expensive material would be bearing the greater factory expense, whereas the actual factory expense incurred may have little, if anything, to do with the cost of the productive material. It may, therefore, be taken that this method of allocating factory expense would seldom work out with any degree of satisfaction, or accuracy.

On Basis of Percentage of Factory Expense to Productive Labour.—The factory expense ratio is arrived at by taking the whole of the productive wages in a department, or works, and dividing same into the value of factory expense, thus giving the required ratio.

The foregoing method is one which is most frequently used in this country: it is, however, only under exceptional circumstances that it may be said to be correct. To assure correctness of allocation of factory expense by this method the following conditions should exist. The department would have to work normal hours, rates of pay would have to be similar, and if workers are employed on machine labour, then the machines must be of a similar class, costing approximately the same per hour to run. It is obvious that these conditions seldom exist: in fact, taking the question of wages alone, there may be two workers at the same rate of pay, doing the same class of work, one on day and the other on night, the latter receiving enhanced rate of pay for night work, or two workers doing the same class of job, in the same shift, but at varying rates of pay, such as a man and a boy.

It will be noted that the factory expense is allocated in proportion to the amount of productive labour expended on the job. Taking the case of a man and a boy working beside each other, doing similar work, the factory expense per hour for such items as rent, rates, taxes, and depreciation, will be precisely the same, and if anything the boy will be working at greater expense per hour for supervision. The foregoing will serve to illustrate the errors in apportionment of factory expense that may arise. If, however, the necessary conditions do exist, this method is the one which should be adopted, as it is undoubtedly one of the simplest and least costly to apply.

On Basis of Productive Hours Worked to Factory Expense.—This method is based on the assumption that factory expense in a department or works is incurred in proportion to the productive hours worked. The rate of factory expense to be charged per hour is arrived at by dividing productive hours worked in the department or works into the value of the factory expense of the department or works, thus arriving at the hourly rate of factory expense to be applied to the cost of product or apparatus. Where departments are solely employed on hand labour, it is generally conceded by authorities on this subject that the hourly rate for factory expense is the correct method to adopt.

The advantages of this system over the previous one may be illustrated by taking the same working factors, and applying factory expense by each method, as follows:—

Working Factors.

(*a*) Man at 1s. per hour, and
(*b*) When on night shift at 1s. 2d. per hour.
(*c*) Boy at 6d. per hour.

Factory Expense at 150 per cent. to Productive Labour, or 1s. 6d. per Productive Hour to Factory Expense.

Application.

—	Hours worked.	Prod. labour.	Factory expense.	Total cost of prod. labour and factory expense per hour.
If applied on percentage of factory expense to productive labour—		s. d.	s. d.	s. d.
(*a*) Man (on day) ...	1	1 0	1 6	2 6
(*b*) Man (on night)...	1	1 2	1 9	2 11
(*c*) Boy (on day) ...	1	0 6	0 9	1 3
If applied on basis of factory expense to productive hours worked		s. d.	s. d.	s. d.
(*a*) Man (on day) ...	1	1 0	1 6	2 6
(*b*) Man (on night) ...	1	1 2	1 6	2 8
(*c*) Boy (on day) ...	1	0 6	1 6	2 0

It will be seen from the foregoing example that by the hourly rate, although workers' rates of pay may vary, also from enhanced rates of pay for night work, that the hourly rate charged for factory expense remains the same. It is reasonable to concede that disposal of factory expense on this basis has more true relation to the facts.

Machine Hour Basis.—Dealing with the machine hour basis of allocation of factory expense, one should examine first of all the nature of the charges comprised in factory expense. These charges may be divided broadly under three headings :—

1. Fixed charges, such as rent, rates, taxes, depreciation, fire insurance, &c., which charges accrue from day to day irrespective of whether the machines run or not, and
2. Term charges, such as supervision, foremen's clerks, lighting, &c., which charges are said to accrue in proportion to the hours run by the machines, and
3. Charges for power, compressed air, &c., which charges have to be dealt with specially, as they follow neither the basis of the fixed nor term charges.

It should be borne in mind that all machine rates have as their basis the assumption that certain classes of factory expense, namely term charges, accrue in proportion to the number of hours the machines run, or are in operation.

The machine hour contemplates ascertaining the cost per hour of factory expense for operating any particular machine or group of machines. There are three distinct methods of costing on the machine hour basis : (*a*) Old Machine Hour ; (*b*) Fixed Machine Hour ; (*c*) New Machine Hour.

The Old Machine Hour has, as its basis, one machine rate to cover all the machines in the department or works. On examination this method will be found to break down as the cost of running the various machines in the department or works may vary considerably, and should hand labour be employed within the department, then this method will break down hopelessly, as it is obvious that hand labour will have a different rate of factory expense per hour to that of machine labour. The old machine rate may therefore be dismissed for all practical purposes.

The Fixed Machine Rate. This rate is an estimate made in advance, based on the assumption that all machines in a department or works are running on complete time. The manufacturer knows full well that such an ideal state of affairs seldom if ever exists, owing to a variety of causes, the chief of which are breakdowns, waiting for material, waiting for tools and drawings, waiting for instructions, waiting for power, waiting for cranes, and idle time. If this system be adopted it becomes necessary to dispose of factory expense, which will remain unabsorbed owing to the idle hours of the machines. This balance of factory expense is disposed of through what is termed a supplementary rate. This rate is applied to the cost accounts in the same manner as the machine rate, thus entailing considerable increase in the work and expense of costing. The advantages claimed for this system are that the unused facility of a department or works is clearly shown up by the supplementary rate. There does not appear to be strong grounds for this claim, as similar information, as to the unused facility, can be incorporated under the new machine method.

New Machine Rate.—This method has all the advantages of the two previous methods, while at the same time overcoming their disabilities. It provides for the variation in factory expense per hour between the different machines or groups of machines. Where the department employs both hand and machine labour, the new machine rate has the additional advantage of enabling the hourly rate for hand labour to be incorporated within the system. The new machine rate is set up on the basis of the probable hours run, based on past records, and in practice it will be found that the factory expense rate so estimated, or set up, works out at very near the actual hours run, thus saving the application of a supplementary rate to the cost accounts. Any small discrepancy, whether from unabsorbed or over-absorbed factory expense, may be dealt with by adjusting same in the monthly departmental trading account. It will be noted that, by comparing the actual hours run with the possible hours run, that the necessary information as to unused facility of machines will be forthcoming.

In connection with unused facility, when a department is partly closed down, the question of apportioning factory expense, in respect of this portion, will require careful consideration, and if such conditions were of anything but of short duration, then the factory expense, in respect of the unused portion, would not be a charge against the cost of the product of that department, but rather against the factory as a whole.

In like manner, in a department having machines, frequently of a special nature, and running for few hours a week only, but which are essential to the manufacture of that department, then the fixed charges, in respect of the time the machines remain idle, should be spread over the production of the whole department, through the medium of the term charges.

Machine Groups.

In a large machine department it will be found that while the new machine rate contemplates a machine rate per hour for each machine, in practice the machines may be grouped under similar classes, having similar expense rates per hour, in which case instead of having numerous rates to be worked, the rates will fall into a small number of groups averaging from three to nine groups in a department.

It will be found that the policy of working on the machine group hour has many advantages, and will considerably reduce the expenses of the cost department in applying factory expense per machine hour to the cost accounts ; as by posting productive hours and labour to the cost accounts under groups, it will be necessary to apply the factory expense on completion of the job only. Whereas when working on rates for individual machines, it becomes necessary to apply the factory expense to each individual time and piece work ticket turned in by the worker ; and this, it will readily be seen, entails a considerable amount of work.

In applying the new machine hour basis to a machine shop it will be necessary, at the outset, to ascertain the factory expense incurred per hour in respect of each machine, and for this purpose the factory expense per hour may be divided under three headings : Fixed charges, such as rent, rates, depreciation, &c., which charges, as previously intimated, accrue from day to day whether the machines run or not. These charges will be apportioned exact to each machine. Term charges are said to accrue in proportion to the hours run of each machine, or group of machines, and comprise such items as charge hands, shop clerks, storekeepers, supervision, timekeeping, costing and works management. The rate per hour for term charges will be ascertained by dividing the total productive hours worked into the value of the term charges, thus giving the rate per hour over all machines and hand labour for term charges. Power charges require to be dealt with separately, as unlike the two preceding items there are two varying factors to consider, these being the varying hours the machines may run, as also the varying horse power used by each machine, or group of machines. Under certain conditions it may also be necessary to specially treat items such as tool supplies, and repairs to machines, by allocating them separately to the machines, instead of including them in the term charges ; the necessity would naturally depend on the conditions of working. If the group machine system be carried out, it will naturally follow that fixed charges for all machines in any particular group will be totalled for the group, also machine hours in respect of each machine in each group will be totalled for the group. The apportionment of power charges for hourly rate, however, requires different treatment. These can be ascertained by adding the nominal horse power of all machines under each group and multiplying them by the machine hours run of each group, giving the nominal horse-power hours in each group, and apportioning the period charge for power in proportion as the sum of the nominal horse-power hours in each group bears to the total nominal horse-power hours of the department. Where machines are run off individual motors the cost of actual horse power consumed would naturally be applied direct to the machines. It will generally be found that such conditions will refer to special or large machines. The addition of the hourly rate of each machine or group of machines for fixed, term, and power charges, will give the machine-hour rate to be charged.

A further method of handling the machine-hour rate is recommended by some authorities. This method contemplates setting up the rate, after termination of the period, in which case all the factors as to hours run are known. The factory expense absorption will naturally coincide with the actual factory expense incurred, and therefore no adjustment would be required for factory expense over or under absorbed.

While this method may be advantageous in certain classes of product it will be found, if same were applied to electrical manufacture, that considerable difficulties would arise. As the rate is not fixed until after the close of the costing period, it naturally follows that no costs can be completed during the current period. This would involve an accumulation of costs which would have to be dealt with at the end of each period, which accumulation would be more expensive to handle. There would also be considerable delay in getting out prompt cost returns, whereas in the method outlined, on the basis of the new machine rate, where the rate for factory expense is estimated in advance, costs can be completed immediately after the completion of the job, thus enabling feeder departments to render charges to main departments, and for main departments to complete the costs of finished apparatus.

Having regard to the varied sizes and classes of machinery in the machine shops of an electrical manufacturing concern, it is the author's opinion that allocation of factory expense can best be handled by the application of the new machine rate, and preferably under the machine group plan.

Absorption of Factory Expense.

Whatever method may be adopted to allocate the factory expense to the product of the department, it is of vital importance that proper records be kept, so as to ascertain the factory expense actually absorbed, as also the factory expense actually incurred, and any discrepancy, as before mentioned, should be adjusted in each monthly period, in the departmental trading account, under the heading of factory expense, under- or over-absorbed. The figure of under- or over-absorbed factory expense is an important index to the efficient working of the department. Information as to factory expense having been obtained in detail, for the purpose of allocation to the departmental trading account, it will be well to reap the full advantages which may be gained from the knowledge of same, by furnishing to the personnel in control of the department such information; both from the point of view of saving factory expense, and also of their having a more intelligent view of the working of the particular department.

In a large works the factory expense may be sub-divided, for the purposes of scrutiny, under three headings:—

1. Those factory expenses which are under or subject to the control of the foreman.

2. Those factory expenses which are under or subject to the control of the superintendent, who may be supervising more than one department.

3. Those factory expenses which are subject to and under the control of the management only.

The foreman will be supplied with the expenses under or subject to his control, and the superintendent and management with the complete information. Provided the information is furnished promptly, there can be little doubt that considerable economies will be forthcoming. The information should be supplied in a manner that can be readily absorbed by the foremen, setting out each period's totals and detailed expenses under their respective headings. A further guide for quick reference may be furnished by setting out in the respective column a percentage ratio of the particular expense to the whole of the expenses of the department, thus detecting at once any undue or disproportionate increase in any particular class of expenditure. Further, if the full advantages are to be reaped from these returns, the personnel in control of the department should be led to understand that factory expenses are not arrived at on any arbitrary basis, but are intended to convey the actual factory expenses incurred by the particular department and those in control have every right, should they think the expenditure unwarranted or unduly high, to question same, and either have the error, if any, adjusted, or be convinced as to the correctness of the charge

Interest in Relation to Costing.

Considerable difference of opinion exists as to whether interest on the fixed assets employed in manufacture, such as buildings, plant and machinery, should, or should not, be included in costs. Most American authorities on this subject advocate the inclusion of interest in costs, whereas the general opinion in this country appears to be to the contrary, and the author leans to this latter view, as it appears to be logical that if interest on the fixed assets is to be included, then interest on the floating assets should also be included. In practice the inclusion of interest on the fixed assets presents difficulties in working, and the inclusion of interest on floating assets would be impracticable. In this connection, and in support of the exclusion of interest, one cannot do better than quote extracts from an article written by Mr. A. Lowes Dickinson, C.P.A. (*see* "Journal of Accountancy," August, 1913), where he deals fully with this subject from the point of view of exclusion of interest from costs.

His fundamental objection is that interest is in fact profit; the practical effects of his objection are: (1) That from the accountant's standpoint, costs are used mainly to value work in progress accounts and inventories, and if interest were included there would be undue inflation of costs. (2) That it is impracticable to determine the rate of interest on any but an arbitrary basis, as money may be raised on mortgage at 5 per cent., or on preferred stock at 7½ per cent., the query arises which rate would be charged. (3) That in methods including interest on plant, buildings, and machinery, there is no interest included on working capital. (4) That to include interest, in costs of operation, results in concealing from those in charge of the business the exact state of two of the most important factors involved in profits, *i.e.*, the amount of capital employed, and the time for which it is employed, and consequently the actual return of the investment necessary to produce it which is yielded by any particular article.

General.

Tool Room Service.—It is the practice in some works to cover the cost of new tools by the addition of a common percentage to the cost of the whole of the product or apparatus. This practice is undoubtedly one which should be avoided, as by charging tools on this basis the apparatus requiring special development for tools does not bear its due proportion of costs, whereas on the other hand the standard product is being penalised for development on tools to a far greater extent than it has actually incurred. It is suggested that the better method of handling the tool room service is to deal with the charge in the following manner: (1) The cost of new tools which are made specially, and which are applicable only to a particular job or apparatus, as also the maintenance of such tools, should be charged directly to the cost of the particular job or apparatus. (2) The cost of new tools for the development of standard or general apparatus or product should be charged to the Factory Expense (or on cost) of the department manufacturing, thereby apportioning the charge generally over the product of that department. The cost of maintenance of such tools should be treated in the same manner.

Power House Service.—The power house should be treated as a separate department, all charges for fuel, wages, rent, depreciation, &c., being charged against same, and the unit cost of the power generated can readily be arrived at by taking the total cost of the power house against the total units of power generated. The cost per unit for purposes of charging out should be based on the units transmitted, and not generated, otherwise the loss in transmission will not be taken care of. The charges for power service to departments will be calculated on the foregoing basis, as per the amount metered to each department.

Engineering and Drafting Charges.—It is the practice in many works to dispose of these charges over the cost of apparatus or product, on a fixed percentage basis. It is suggested that these charges can be best handled in the following manner: (1) Engineering and drafting applied to special development in connection with particular apparatus, in which case the cost of engineering and drafting should be charged against the particular apparatus. (2) Engineering and drafting employed in connection with the general product of the department should be charged to the particular department's factory expense. (3) Engineering and drafting employed on development in connection with projects and tenders would not be charged against the particular works department concerned, but against the selling expenses.

The cost of scrapping material due to either bad workmanship, faulty material, or incorrect design, should be charged to their respective accounts, and a return should be made to the management each period, setting out the cost of such scrapped material under its respective heading.

In conclusion: Where manufacturers have more than one works under their control, one of the greatest aids to efficiency is correct comparison of costs, as between one works and another on similar classes of product. Whilst admitting that owing to varying conditions costing cannot be carried out on a precisely similar basis, it will be conceded that a uniform system of accounts, departmental trading accounts, and costing can be applied, which is capable of producing accurate and comparable trading and cost results.

Telephone Repeaters.*

By B. GHERARDI and F. B. JEWETT.

(Continued from p. 519.)

III. The distinction between electronic and gaseous repeating elements is not a matter of the presence or absence of gas, since an absolute vacuum is unobtainable. It is rather a matter of whether or not gas is an irrelevant and undesirable element or an indispensable one.

III. (*a*) In the repeating element of von Lieben, invented in Europe somewhat later than the time the audion was produced here, gas is an essential constituent. This device has a Wehnelt cathode, *i.e.*, a filament coated with oxides of the alkaline earths from which electrons are thermionically emitted. The function of the cathode is not, however, to provide all the carriers as in the case of the filament of the audion, but rather to provide means for ionising the gas present in the tube. The tube is a three-element device and has, in addition to the thermionic cathode, an anode of aluminium and an intermediate sieve-like electrode in the form of a perforated aluminium disc. If the cathode and sieve are used as the input circuit, corresponding to the filament-grid circuit of the audion, the impedance of this input circuit will vary with the impressed voltage, resulting in a serious distortion.

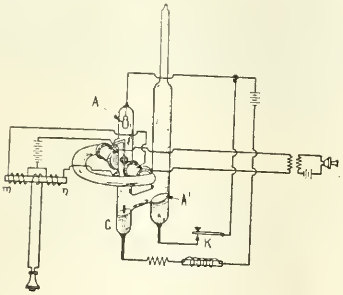

Fig. 7.

The presence of both kinds of carriers makes impossible the simple expedient which is so valuable in the case of the audion where the unilateral conductivity of the grid-filament circuit is utilised. Further the pressure of the gas within the tubes is subject to fluctuations, almost impossible to control and resulting in large variation in amplification. In comparison with the electronic device the von Lieben tube is seriously deficient as a telephone repeater, and the electrostatic control of gaseous devices has not been found capable of as efficient and simple application to telephonic problems as is the electrostatic control of electronic devices.

III. (*b*) The electromagnetic control of gaseous devices has likewise been investigated for telephonic purposes. The oppositely moving streams of positive and negative carriers will be deflected in the same direction by an electromagnetic field. Provided that the motion of such a discharge stream may be made to alter properly the conductivity of either the circuit of the discharge itself or of some auxiliary circuit a repeating element may be formed.

Some of the early work on such systems is that of Hewitt, whose experiments on mercury vapour arcs are well known. A later step in the development of an electromagnetically controlled mercury arc repeater was taken by Dr. H. D. Arnold. He utilised an auxiliary circuit for the output and so disposed it that its conductivity was altered in conformity to the motion of the arc stream. In the general idea of using a mercury arc stream and influencing it magnetically, Arnold, of course, follows Hewitt.

The device as originally described for patent is shown in Fig. 7. An auxiliary anode, formed by a mercury electrode shown at A' is used for starting the arc stream. In this form the arc is struck by tilting the tube and allowing the mercury of the anode A' to run into contact with that of the main cathode C. As the tube is restored to its vertical position an arc is formed between A' and C, provided that the key K has been closed. Opening the circuit at K allows the arc to form between C and A.

This gaseous device is capable of good amplification and is fairly free from distortion except such as may result from the impedance of the electromagnet being identical with that of a telephone line. It was tried experimentally on telephone lines, but has never been used for any length of time and then only under special engineering supervision.

III. (*c*) The third type of gaseous device which we have investigated as a possible repeater is the negative resistance type.

For an ordinary resistance the slope of the relation of voltage and current is positive in the usual sense, since for any point on the curve dV/dI is positive, and represents a slope of less than 90 deg., measured counter-clockwise from the axis of I. For the arc, however, with its falling characteristic, the slope is negative. The resistance which the arc offers to a change in its condition is thus to be considered negative.

If an arc is connected in series with an ohmic resistance and a source of potential, as shown in Fig. 8, the arc, owing to its falling characteristic, has the effect of making the total resistance in the circuit appear to be less when small current variations exist in the circuit than when steady conditions exist. Any small increase in current is accompanied by a decrease in the voltage across the arc itself, thus leaving a still greater voltage across the ohmic resistance than would be obtained if the circuit consisted merely of elements obeying Ohm's law. If the source, V, is a transmitter and if there is in the circuit also a receiver, the energy received by the latter may, under proper conditions, be greater than that delivered to the circuit by the transmitter. In other words, there is a possible telephonic amplification, to a degree which depends upon the relative magnitudes of the negative resistance and the external ohmic resistance. The external resistance may in part be that of a telephone line. The negative resistance of the arc can never do more than remove some of the effects of the external resistance. If it could do more, the circuit would "sing." We have found that

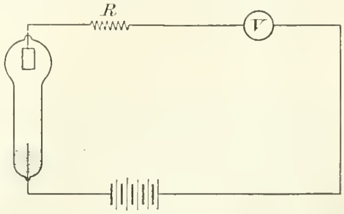

Fig. 8.

the system can never increase the loudness of telephone speech unless the line resistance itself is sufficient to stabilise the arc. In practice the arc would have to be connected to various telephone lines, each having different characteristics, and in order that an arc which will amplify, when connected to a high resistance line, shall not "sing" when connected to a line of lower resistance, a certain amount of extra external resistance has to be added to the arc circuit, which resistance will be different for each different type of line. For practical telephony, therefore, this negative resistance device is not of service. Moreover, the dynamic characteristic of the arc varies with the frequency of the impressed telephonic waves, giving prohibitive distortion and variable amplification. Finally, the negative resistance device would be too unsteady for practical use.

The two devices which we have found practicable under the exacting requirements of commercial telephone service are the receiver-transmitter element and the three electrode vacuum tube or audion. The electromagnetically controlled arc stream with auxiliary electrodes, although used by us to a limited extent experimentally, and possessing many of the characteristics of a commercial telephone repeater, is not in its present state of development adapted to general telephonic use. Of the three types, mechanical, electronic and gaseous, the electronic device with its thermionic emission is the most nearly perfect.

The Repeater Circuit.

The electrical network by means of which one or more repeater elements may be associated with the telephone lines is conveniently known as the "repeater circuit." In two-way operation, such as telephony requires, there may be distinguished three general types of such circuits, of which the bridge or balanced circuit is the more usual type.

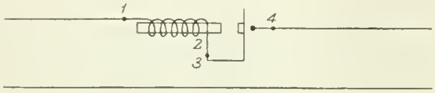

Fig. 9.

The other types, *e.g.*, "the booster," do not depend upon balance for their successful operation. Fig. 9 shows one form of series booster, in which the input and output of the element are connected in series with each other and with the line. A form of shunt booster is similarly indicated in Fig. 10. Many other forms of booster circuit are possible. Negative resistance devices are adapted to the booster scheme of connection. In booster circuits there is, for operation without singing, a limiting relationship between the amplification and the impedance of the line. Part or all of the output currents from the element must flow through the input circuit of the element itself. Thus the amplification of the incoming telephonic current depends upon the "building up" of currents in the circuit by the interaction of input and output. If the lines do not offer a sufficient load such a circuit with its element may act as an oscillation generator, *i.e.*, there may be singing.

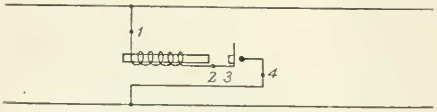

Fig. 10.

The third type of repeater circuit is somewhat analogous to the single line repeater of telegraph practise. Incoming voice currents operate sensitive relays which switch the terminals of the element according to the direction from which the voice currents originate so that the circuit is equivalent at any instant to a one-way repeater circuit. These types of circuit, which do not depend upon balance, have in general been found not so desirable for practical use as the bridge type of duplex circuit and will not be discussed in further detail.

The "21-Type" of Circuit.

Of the bridge type we may distinguish two classes depending upon whether a single repeater element is used to amplify transmission in the two directions or whether separate elements are used for the opposite directions. The typical circuit shown in Fig. 11 is obviously of the first class. Such circuits we may call "21-type," indicating two-way, one-element circuits. The other class, which we shall discuss a little later, is generally known as the "22-type," since it is a two-way, two-element circuit.

The input and output terminals of the element in the 21 type circuit, may obviously be interchanged without altering the physical operation of the circuit, in which case the element transmits to the two lines in parallel instead of in series. The choice between these two connections is influenced largely by the ease with which, through the medium of repeating coils, the input and output impedances of the element may be made similar to the impedances of the network to which they are connected.

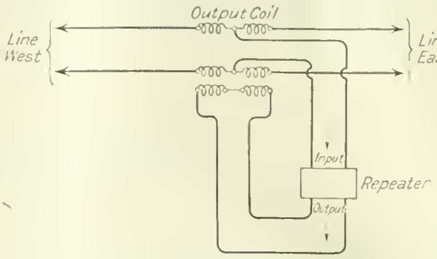

Fig. 11.

A practical form of the 21 circuit is shown in Fig. 12 with its associated vacuum tube amplifier. The incoming energy is supplied through an input repeating coil, between which and the telephone lines is interposed a "filter" (not shown). This filter is a physically periodic structure, consisting of similar networks in series, which is so designed as to discriminate against the passage of sinusoidal currents of frequencies above or below the necessary telephone range. It thus prevents the element from receiving currents which arise from the simultaneous use of the metallic circuits of the telephone line for telegraph currents or other signal currents. The potentiometer regulates the gain occasioned by the element. Retardation coils and condensers prevent cross-talk into adjacent telephone circuits and to permit the use of a common battery to supply all the repeater sets at any repeater station. A rheostat controls the heating of the filament and thus its thermionic emission.

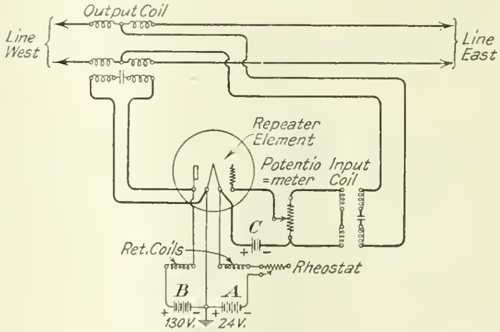

Fig. 12.

(*To be continued.*)

Scientific Method—Its Philosophy and Practice.

In a book with this title, Mr. F. W. Westaway's aim is to show those interested in scientific teaching how important is a knowledge of philosophical thought and the history of scientific method from the time of ancient Greece to the present day. The history and methods of the chief philosophers and scientists are briefly described, showing where they failed and how they helped the advance of scientific thought. The end of the book deals with some elementary principles of science teaching. The importance of teaching the pupils to form their premises from their own personal observations is emphasised. The appendix deals with a review of German and English methods of education, and a plea in the curriculum of English schools and universities for a larger place for research. The book is one which should be in the hands of every teacher of science.

The Largest Rolling Mill in the World.

A 20,500 h.p. Electrically Driven British Installation.

(*Concluded from page* 521.)

EXCITER SET AND AUXILIARIES.

The exciter set is a five-unit set embodying the following machines: (1) An induction motor for driving the complete exciter set; (2) an exciter for the main generators; (3) an exciter for the mill motor; (4) a booster working in conjunction with the exciter for the mill motor; and (5) a small direct-current generator used for exciting various machines and driving auxiliary motors. The exciter set driving motor is a three-phase slip-ring induction motor, rated 200 H.P., 770 revs. per min., 2,750 volts, 40 cycles, and calls for no special comment. The exciter for the main generators has three field windings, the functions of which are as follows: (*a*) main shunt field winding regulated and reversed by controller; (*b*) differential shunt field winding connected across the armature of one of the main generators; and (*c*) differential series field winding connected across an inductive diverter in the main circuit supplying the mill motor.

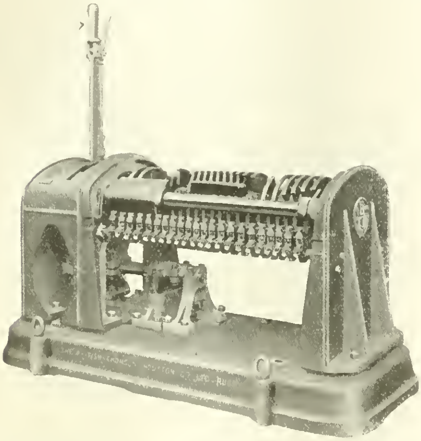

FIG. 6.—VIEW OF THE CONTROLLER WITH COVER REMOVED.

The action of these fields in relation to each other is as follows: The exciter field windings (*a*) and (*b*) oppose each other and normally maintain a balance which results in an exciter field strength corresponding to the particular main generator voltage at the time, *i.e.*, to the actual position of the controller handle. When the mill motor is reversed, if the controller handle is moved quickly with the object of varying the main generator voltage suddenly, the relative values of the exciter field windings (*a*) and (*b*) will become unbalanced. The effect of this will then be as follows: Commencing with the controller in the "off" position, the main shunt field winding (*a*) is now unexcited, therefore the main generator field winding is also unexcited and consequently the differential shunt winding (*b*) is unexcited.

Assume now that the controller handle is moved quickly so that the main generator field is built up and the mill motor starts rotating. If the main generator voltage lags behind the exciter voltage the ampere turn value of the differential shunt field winding (*b*) will be *less* than if no lagging had occurred. The result of this is that the normal balance between the exciter field windings (*a*) and (*b*), which, as previously stated, oppose each other, is disturbed. Consequently the resultant ampere-turns on the exciter field will increase in value, thus compelling the main generator field, and therefore the main generator voltage, to build up more rapidly than would otherwise be the case, until the balance between the exciter field windings (*a*) and (*b*) is again restored.

When the main generator voltage is reduced on reversing the mill motor a converse result will be obtained. In this case if the main generator voltage does not die away as quickly as the exciter voltage the ampere-turn value of the differential shunt field winding (*b*) will be *greater* than if no lagging had occurred. The relative values between the exciter field windings (*a*) and (*b*) again become unbalanced. The resultant ampere-turns on the exciter field will decrease in value and thus the main generator field will tend to decrease rapidly in strength until the generator voltage reaches the value corresponding to the position of the controller handle, when a balance between the exciter field windings (*a*) and (*b*) is once more restored.

The main effect, therefore, of the differential shunt field winding (*b*) is to decrease the period required for the field of the main generators to build up or die away and consequently the time required to reverse the mill motor from 40 revs. per min. in one direction of rotation to 40 revs. per min. in the reverse direction. The actual time required for the reversal is less than 3 seconds, which is an extraordinary good result for such a large machine.

Subsidiary effects of this field winding (*b*) are: (1) To neutralise any residual flux remaining in either the exciter or the main generators, and thus to prevent "creeping" of the motor, with the controller in the "off" position from taking place; and (2) to tend to prevent the main generator voltage from increasing excessively when the mill motor is reversed while running light.

The function of the differential series field winding (*c*) is to reduce the exciter voltage in the event of excessive overloads on the mill motor, and to reduce the maximum short circuit current which, would flow between the main generators and the mill motor in the event of the mill "stalling."

The excitation of the mill motor is obtained from the exciter (3) and booster (4) in the following manner. The exciter has two shunt field windings: (*d*) a main shunt field winding controlled within required limits by contacts on the "Ward Leonard" type controller, and (*e*) an auxiliary shunt field winding excited by the booster, which either opposes or boosts the main shunt field winding (*d*) as required. The booster has also two field windings: (*f*) a field winding connected in series with the main shunt field winding (*d*) of the exciter, and (*g*) a field winding connected in the mill motor field circuit.

The two booster field windings (*f*) and (*g*) oppose each other and under steady conditions there is no resultant flux. When the mill motor is speeded up, the time lag of the motor field causes the field (*g*) of the booster to be stronger than the field (*f*), and

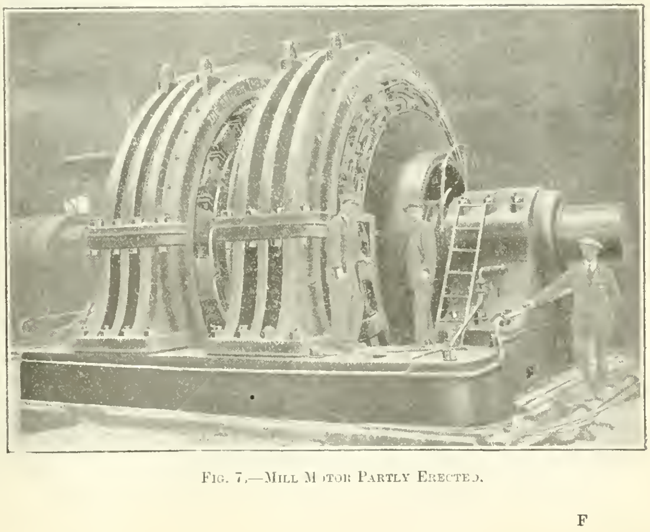

FIG. 7.—MILL MOTOR PARTLY ERECTED.

thus a resultant voltage is generated in the booster armature. This resultant booster voltage excites the auxiliary shunt field winding (e) of the exciter in such a direction that the flux of the latter is decreased, thus causing a temporary drop in the exciter volts and a corresponding weakening of the field of the mill motor. As the mill motor field reaches the steady value corresponding to the position of the controller lever, the booster volts gradually drop to zero. The effect of the foregoing is to reduce the time required to accelerate the mill motor from 40 to 70 revs. per min.

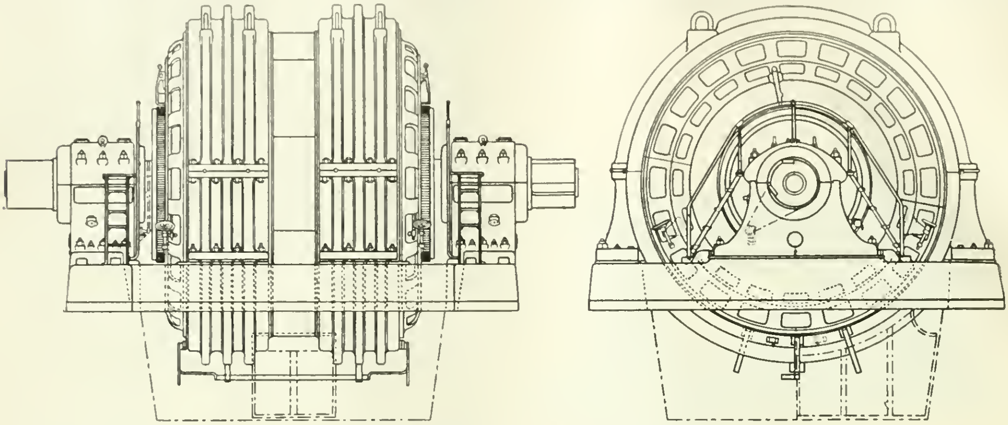

Fig. 8.—Outline Views of Mill Motor.

Similarly, when the mill motor is slowed up, the time lag of the mill motor field causes the series field winding (*g*) of the booster to be weaker than the shunt field winding (*f*), resulting in a booster voltage which is in a reverse direction to that which was the case when the mill motor was accelerated. The auxiliary shunt field winding (*e*) of the exciter is, therefore, excited in a direction which assists the main shunt field winding (*d*), thus temporarily boosting up the exciter voltage and impressing a higher voltage on the field of the mill motor. The booster volts again drop to zero when the booster fields become equalised. The effect of the foregoing is to reduce the time required to decelerate the mill motor from 70 to 40 revs. per min.

With this arrangement of excitation for the mill motor the time actually taken for the motor field to build up or die away is only a small fraction of the time required when the special field windings, as described above, are disconnected. There is no doubt that this mill motor could be reversed from 70 revs. per min. in one direction of rotation to 70 revs. per min. in the reverse direction in about 5 seconds.

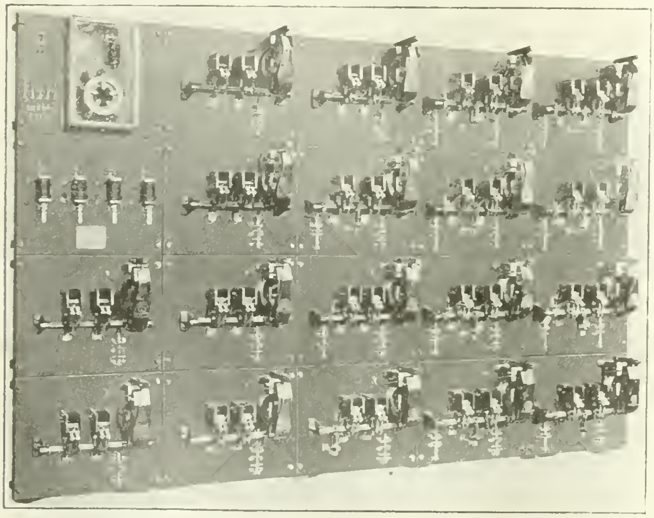

Fig. 9.—Starting and Slip Regulating Contactor Panel Controlling the Rotor of the Slip-ring Induction Motor for Driving the Fly-wheel Motor-generator Set.

Direct-Current Switchgear.

The direct current switchgear consists of a main instrument panel, an exciter field panel, a main generator and mill motor field panel, and an exciter panel for the small direct-current supply generator for the auxiliaries.

Controller.

The controller is mounted on a platform overlooking the main rolls, so that the operator of the controller has a full view of the mill, and is thus able to follow the various passes and manipulations of the billet.

The controller is illustrated in Fig. 6, and consists of a horizontal cylinder with reversing and regulating contacts for the generator exciter, regulating contacts for the mill motor exciter and interlocking contacts for the circuit breakers. The contacts for the motor exciter are arranged so that the resistance is not cut in until after all the resistance is cut out of the generator exciter field. The cylinder is operated through gearing by means of a lever working in a slot on the gate principle. Dashpots, with needle-valves for adjusting the action, are used to prevent too rapid an operation of the lever. A push button for tripping the circuit breakers in emergency is mounted on the controller frame. The various parts of the controller have been very heavily constructed on account of the rough handling which mill apparatus of this description usually receives.

Mill Motor and Auxiliaries.

The mill motor is illustrated in Fig. 7, and Fig. 8 shows an outline. The motor is a double-unit machine with the two units connected in series, the mid-point being at earth potential, so that the maximum voltage to earth is 800. The continuous capacity of the motor is 6,750 h.p. at 40 revs. per min., 1,600 volts, and a peak load capacity of 20,500 h.p., 1,600 volts, 40 revs. per min. The speed can be further increased up to 70 revs. per min. by weakening the motor field.

Oscillograph tests on a similar motor built by the British Thomson-Houston Company show that this machine is capable of being reversed from 40 revs. per min. in one direction to 40 revs. per min. in the opposite direction in less than three seconds. This rate of reversal is considerably greater than will usually be required in service. The maximum peak-load corresponds to a torque of approximately 1,200 ton-ft. (2,700,000 lb.-ft.), and the motor is thus the largest which has been built in any country up to the present time.

The bearings are arranged for either oil or grease lubrication. The oil lubrication is pressure fed from an overhead tank which is kept full by a duplicate system of oil-pumps driven by small auxiliary motors. The mill motor is ventilated with filtered air from a wet air filter located in a pit close to the motor-house, and is driven by an auxiliary induction motor. The weight of the complete mill motor is 420 tons and the weight of the revolving part 120 tons. The journals are 30 in. in diameter. These figures give some idea of the immense proportions of the motor.

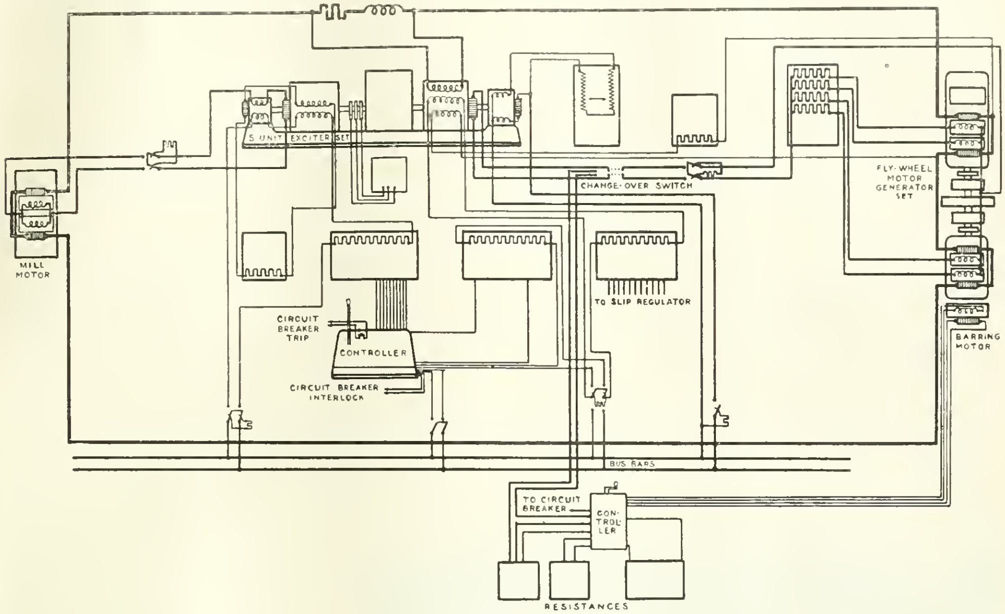

Fig. 10.

Slip Regulating and Starting Contactor Panel for the Motor Generator Set.

In view of the intermittent nature of the load on the mill motor and consequently on the main generators supplying current to the same, and in order to obviate too heavy a demand from the supply system, a special starting and slip regulating contactor panel is provided for the control of the induction motor driving the flywheel motor-generator set.

The panel controls the rotor circuit of the motor only, the stator being controlled by separate oil-break switchgear. The panel is illustrated in Fig. 9 and has mounted 18 double-pole alternating-current contactors, four notching relays for controlling the same and a special quick acting overload relay for giving the slip regulating feature. The latter relay is shown in Fig. 9 at the top left-hand corner of the panel.

Eight of the 18 contactors are used for starting the motor, the remaining ten complete the starting cycle and provide the slip regulating feature. Two of the notching relays control the starting contactors and the remaining two are used to notch back the slip regulating contactors after the quick acting overload relay has caused them to open successively. When the induction motor has been started up and the mill motor is running light, the last of the starting, and all of the regulating, contactors are closed. All the external resistance in the rotor circuit of the induction motor is thus short-circuited with the exception of a small amount of resistance which is permanently left in circuit.

With peak loads of very short duration this permanent resistance causes the induction motor speed to decrease sufficiently to enable the flywheel of the motor generator set to give out enough energy to carry the set through such peak loads. The energy available, however, would not suffice should a heavier overload of long duration follow, and as a result the load would be transferred from the flywheel to the induction motor again. The stator current of the motor will in consequence increase, and on reaching a certain predetermined value will cause the quick-acting overload relay to operate. The first of the series of slip regulating contactors will then open, thus inserting additional resistance in the rotor circuit. The speed of the induction motor will consequently tend to decrease and the load will be transferred to the fly-wheel, which will give out energy while decreasing from the old speed to the new speed, as determined by the amount of resistance inserted in the rotor circuit.

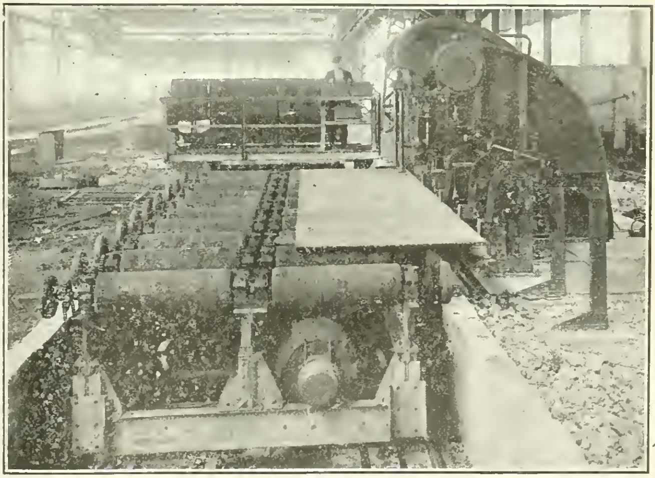

Fig. 11.—View of the Special Plate Handling Table.

The stator current input will then decrease, causing the quick-acting relay contacts to close, with the result that only one of the slip regulating contactors remains in action. If, however, the overload persists, the fly-wheel, having decreased in speed to that corresponding to the amount of rotor resistance inserted, will be unable to give out more energy and the induction motor must again deal with the load. The stator current will increase a second time, and at the same predetermined value the quick-acting overload relay will operate again, opening the second slip regulating contactor and inserting a further amount of resistance in the rotor circuit. As previously described, the motor will then still further tend to decrease in speed and thus allow the fly-wheel to relieve the motor of a portion of the load.

These series of operations will continue until the peak load is removed or until all the resistance is inserted. When this occurs the slip regulating contactors which have been opened under the action of the quick-acting overload relay will be closed again by the notching relays previously mentioned. The resistance which has been inserted in the rotor circuit is thus cut out, enabling the motor to regain normal speed, and the fly-wheel to store up more energy ready to deal with the next peak load on the system, in a similar manner. A diagram of connections is given in Fig. 10.

The voltage drop in the main generators is compensated by cutting out a resistance in the exciter circuit by special contacts on the slip regulating contactors. This keeps the voltage approximately constant even when the generator speed falls considerably.

Auxiliary Plant

All the auxiliaries in the plate mill are driven by G.E.C. motors. On leaving the mill the plate passes through a straightening machine, driven by a 250-h.p. B.T.-H. motor, and then to the hot bank where it is handled by means of G.E.C. skid magnets of novel design, which take the plate off at right angles to its former direction. The plates are delivered by live rolls to a special plate handling table, as shown in Fig. 11. This table is provided with a series of specially designed rotary magnets, these being operated by motors and moving the plate at right angles to the former position. A combination of this motion and live rolls enables the plate to be easily turned round to any angle, and so sheared in exactly the required manner. The whole of the operations are carried out by one man; small master switches being employed which in turn operate special contactor gears. This arrangement takes the place of the castor method which is usually used in connection with hand manipulation in shearing plates. The machine is the first of its kind to be constructed, and the results obtained have been most gratifying.

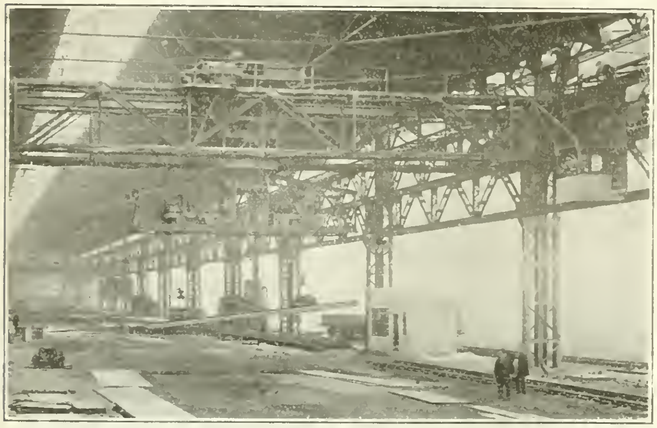

Fig. 12.—The Plate Handling Magnet Crane.

After plates have been sheared, they are taken away by a specially-designed plate handling magnet crane, as shown on Fig. 12. This machine is equipped with many novel features, amongst which it will be noticed that two separate hoists are provided. These hoists are arranged so that their lifting centres can be easily adjusted to suit the length of plate being handled. It will also be noticed that the special underhung structure revolves to any angle required.

Specially designed magnets are used for lifting plates, and controlled by a special master control arrangement, so that one or more magnets may be employed as found necessary.

The operation of such a large amount of electrical equipment necessarily means a good deal of maintenance and repair work. Very complete shops for carrying out these operations have been established at Warrenby. We have to thank Messrs. Dorman & Long for permission to view this very interesting installation and their chief electrical engineer, Mr. A. Davidson, for spending a good deal of time with our representative explaining the various features of the installation. The photographs and drawings illustrating the article have been supplied by Messrs. Dorman & Long, the British Thomson-Houston Company, Messrs. Reyrolle & Company, and Messrs. Babcock & Willcox.

Correspondence.

MR. E. J. P. BENN AND SOVIETISM.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of April 30, Mr. Benn lightly tells us that " the Soviet is as good as dead when the facts come to be known." Does Mr. Benn know the facts, or has he taken for facts the statements of a certain section of the Press?

As one who was in Russia during the revolution, talking with the people, reading the papers, and meeting a number of English, some of whom have written accounts to the Press, I venture to think I have grounds for discrediting the evidence of some critics and accepting that of others. If Mr. Benn can conceive a country, unwieldy both as regards size and transport facilities, with very limited manufacturing resources, hemmed in by enemies, and recently passed through the throes of a disorganising and disintegrating revolution (it will be remembered that the Bolshevik revolution was not the first), he will have some idea of Russia to-day.

Mr. Benn should recognise that the Bolshevik Government has kept in power, organised military defence against internal and external enemies on a vast front with most inadequate rolling stock, has grappled with difficulties of food transport, and has even made progress with educational schemes and internal reforms, according to the statements of reliable men in certain papers. These things are not done without support, least of all in a country as large as Russia: we have recently seen in Germany how transient is a Government that has not popular support in a revolutionary country.

Will Mr. Benn say in what respect the Soviet Government has adopted Capitalism? Militarism has been forced upon it: it is against the Bolshevik principles, but what Government has ever stood to principles in so great an emergency one liberty after another was sacrificed in this country during the war at the altar of Expediency, and the ability of the Russian Government to impose conscription argues a degree of enthusiasm and support in a war-weary country which the British Government could not claim in Ireland.

I do not claim that the Soviet Governmentis the best or only form of Government, but I think that when the facts come to be known it will be admitted to be a success, and it will become increasingly successful as conditions improve. I am, &c.,

New Eltham, May 10. L. C. Pocock,
Late Radiographer Anglo-Russian Hospital.

We have submitted the above letter to Mr. Benn and have received the following reply:—

TO THE EDITOR OF THE ELECTRICIAN.

Sir: If Mr. Pocock will compare the early speeches of Lenin with the results of his actions as now disclosed by himself, he must agree that the principles upon which the Soviet is founded are as good as dead. My language may have been careless. The Soviet itself is still alive, but simply as a variant of Czardom, relying upon militarism and including a new tyranny, the conscription of labour.—I am, &c.,

London, May 11. E. J. P. Benn.

Direct Current Compared with Three-Phase Current for Driving Steel Works Plant.*

By C. A. Ablett.

Many steel works and rolling mills have adopted three-phase plant, and others direct-current plant; there is justification, therefore, for a consideration of the two systems.

The three-phase system enables power to be transmitted cheaply over long distances at high voltages; but three-phase motors are not capable of speed variation without much loss of power, unless they are of a complicated and costly type, and are not well suited to many steel-works purposes. Direct current is not well adapted to long-distance transmission; but in most iron and steel works this is not of great importance. Direct-current motors are capable of wide speed variation without loss of power; this renders them very suitable for steel works.

Application to Various Operations.

The Author, in the original Paper, considers the method of applying electrical power to the various plant in steel works in detail, dealing in succession with rolling mills, sheet and tinplate mills, reversing rolling mills and live roller gear. In rolling mills a feature is the variety of processes, each requiring its own special speed. In this work the direct-current motor has some considerable advantages which the Author illustrates by a diagram comparing the working of a 1,200 h.p. direct-current motor with a three-phase motor of similar output. Devices are available which facilitate better speed regulation of three-phase motors without excessive loss of power; but they are more expensive, less economical and more complicated than the direct-current machine. Automatic slip regulators for the intermittent variation of the speed of mill motors are too slow in action to be of value in most rolling mills. In America, where three-phase motors are more used, there are special features in practice which render exact speed regulation of less importance.

Where Steam is an Advantage.—Sheet and tinplate mills involve very great variations in power, and the Author is disposed to agree with the statement that it is cheaper to drive hot mills by steam than by electricity. In cold mills there is little to choose between direct current and alternating current, as they require practically constant power to drive them at a constant speed.

In reversing rolling mills electric driving has found wide adoption, and a direct-current motor is about three times as effective as a three-phase motor in helping the power house to overcome peaks.

Live roller gear, where rapid handling is of great importance, offers another case where the direct-current motor is preferable.

Power Generation.—The cheapest way of obtaining power in iron and steel works is to utilise the blast-furnace and coke-oven gases, or other sources of waste heat, to the fullest extent economically. Where large slow-speed alternators are driven by gas engines peculiar and troublesome resonance effects may be produced. If the alternator be driven at a uniform speed, it can be set swinging by a sudden overload or other causes, at its natural time of vibration about its uniform speed of rotation. If the alternator and flywheel are properly designed, these vibrations should die away quickly; but if the natural time of vibration coincides with the time which elapses between successive working strokes of the engine, or certain multiples of them, the vibration may become so violent that it is impossible to run the engine.

If a number of gas-engine-driven alternators be running in parallel, serious difficulties can occur by the natural time of vibration of one alternator coinciding with the time between the working strokes of an engine driving another machine, so that it becomes impossible to run the two machines in parallel.

To avoid such resonance, a flywheel heavier than would be necessary to secure uniform running of the engine if it were not driving electric machinery must be selected. Gas-engine-driven direct-current machines are usually cheaper in capital cost than gas-engine-driven alternators, and have the advantage that these resonance troubles do not take place.

Steam Turbines.—Steam turbines direct coupled to three-phase alternators have been built in large sizes, and have proved very reliable. A number of high-speed direct-current turbo-generator sets with dynamos direct coupled to steam turbines running at speeds up to about 2,000 revs. per min. have been installed in steel works with satisfactory results. The modern tendency, however, is to build direct-current turbo-generators with a high-speed turbine driving a comparatively slow-speed dynamo through some form of double-helical gearing, or a development of it. Such machines have been built in sizes up to 6,000 kw. Ultimately the construction of considerably larger sizes, running at higher speeds than 3,000 revs. per min. (the highest possible speed of a three-phase 50-cycle turbo-alternator), are probable. Such gear-driven sets have proved reliable, and there is little to choose between three-phase and direct-current turbo-generators, though the capital cost of the former is less.

Power Supply.

Since it is often advantageous that direct current should be adopted in steel works, the question of linking-up with the power supply authority is important, because such authorities as are here concerned nearly all supply three-phase current.

As arguments for linking-up, it has been suggested (*a*) that the power supply authority provides a stand-by to the works power house; (*b*) that the power supply authority provides a possible market for the surplus power of the works.

Neither reason, from the power company's point of view, contains much substance. Thus, if a power supply authority undertakes to provide a certain stand-by, it must invest capital in additional plant, and also upon its distribution system. The power supply authority has capital, depreciation and maintenance charges to meet on this additional plant provided for stand-by purposes, which involve a definite payment per kilowatt which it contracts to keep as a stand-by and to supply upon demand.

The stand-by supply may be regarded as an insurance against exceptional circumstances. It is therefore necessary for the works owner to assure himself that the power supply authority is providing at the commencement and during the whole term of the agreement the plant necessary for providing a stand-by supply at any time at which it may be required. He can test this by demanding the stand-by supply occasionally unexpectedly.

It would appear better for a works having blast-furnace gas, coke-oven gas or other natural sources of power, to install their own stand-by plant rather than pay other people to do it for them. If they install their own plant and charge themselves annually a similar sum to that which they would be paying a power supply authority the cost of the plant would soon be paid off. If, on the other hand, they rely upon the power supply authority, this annual charge goes on perpetually.

In considering that the power supply authority provides a possible market for surplus waste heat power for the works, the question arises of what price the power supply authority would be willing to pay for this surplus power. Now, from the power supply authority's point of view, surplus power is not of great value, because, as a rule, it cannot be supplied to it when it is important. If the power supply authority could depend on regularly obtaining a considerable supply of surplus power during the ordinary working hours of the day, they would probably be prepared to pay a good price for it, because they would be able to conduct their business with less plant and to keep their plant more continuously employed. The works, however, as a rule, need the full output of their own power plant for themselves during the ordinary working hours.

It is evident, therefore, that the interests of the iron and steel works having their own power resources and those of a power supply authority do not coincide. As a power supply authority is bound to make such considerable charges for stand-by plant, and can only pay so small a price for surplus power, which is less than the cost of production, there appears to be no advantage in linking up with the power supply authority. It would be more profitable to the iron and steel works to find a means for using their own surplus power which is one of their valuable assets.

In order to improve the telephone service in Liverpool about 1,250 subscribers' circuits have been transferred from Central Exchange to Bank Exchange. To meet the growing requirements of the city the principal and oldest exchange—viz., the Central—is being transferred to new apparatus in premises adjacent to the Bank Exchange. It is hoped that the work involved by the transfer will be completed by August or September next, when subscribers will have the benefit of up-to-date switching arrangements of the common battery type. The completion of the new Central Exchange will enable the Post Office to deal with a large number of outstanding orders which have been waiting for switchboard equipment, and will also improve the trunk facilities.

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* Abstract of a Paper read before the Iron and Steel Institute.

The Business Exhibition.

The principal exhibits of electrical interest at the Business Exhibition, which is being held at the Agricultural Hall, London, and will close on May 14, relate to the use of the telephone as an aid to business efficiency. Foremost in this connection is a large exhibit by the Telephone Manufacturing Company, Ltd. of Hollingsworth Works, West Dulwich. This firm makes a speciality of the "New System" of internal telephone communication, which is in no way a substitute for the Post Office private branch exchange, but is advocated as the greatest auxiliary in conjunction with the Post Office extensions. The Company places a considerable variety of internal telephone applications before business men. For instance, there is a selective control system whereby principal officials can, at will, isolate their instruments from the rest of the system and carry on a confidential conversation entirely free from third party interruption. The whole of the electrical energy for the working of the exhibits on this stand is supplied by a specially adapted C.A.V. dynamotor, accumulators of power panel, a form of equipment extensively used for the supply of energy required in the larger telephone installations supplied by the Telephone Manufacturing Company.

The Relay Automatic Telephone Company, Ltd., Marconi House, Strand, show the relay automatic telephone system which has been designed to supply a telephone system which is secret, reliable, quick in action, and does not readily go wrong. This development in automatic telephony which has numerous applications both in public and private systems, marks a departure from the hitherto adopted forms of electric mechanical movement in automatic telephone systems. The system consists of telephones with calling devices, the exchange switchboard and the wiring. To the ordinary pattern telephone is attached a dial switch, by means of which any desired number may be selected. It consists of a circular plate with ten holes, and through each hole a number is seen, the numbers being consecutively 1 to 9 and 0. The exchange switchboard consists of relay units mounted on an iron rack, the relays used being of a type which has been evolved after many years experience. They are fireproof, dustproof, and do not require oiling or cleaning, an important point, especially in private installations. As will be seen, an operator is dispensed with, all the operations of connecting subscriber to subscriber, ringing and disconnecting, being performed entirely by relays. The system first came into public notice just before the war, and progress was naturally hindered thereby, but the system has been worked in Sweden on a 1,000 line public installation with very satisfactory results.

Automatic inter-communication telephones are also shown by the Reliance Telephone Company, Ltd., of 12-13, Henrietta-street, London. This firm, like others, installs these telephone systems on a rental basis, and although they differ in technical details, the apparatus fulfils all the functions of secrecy, executive control, round calls, &c., which are the concomitants of all inter-communication telephony.

The Marconi International Code Company, Ltd., has a stand for the purpose of securing subscribers to its international code system. Its compilation has entailed three years' work by a large staff of experts, and a message sent in this code will be understood by any recipient speaking any of the nine chief languages of the world.

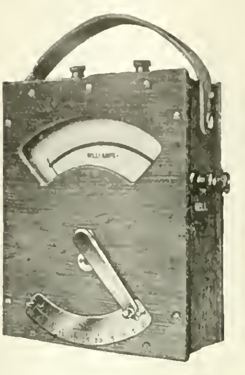
A minor but important application of the telephone is the "Junior Dictograph" exhibited by Dictograph Telephones, Ltd., of Denman-street, London, S.E. Briefly this apparatus is a telephone which will liberate the spoken word so that it is audible in any part of the room in which the apparatus is placed. At the speakers end, too, it is not necessary to speak close into the instrument, which is a small cabinet, finished in either mahogany or oak. The telephone may be spoken to from any part of an average size apartment. There are many obvious advantages in this apparatus from the point of view of time saving, and it saves an enormous amount of running about between the rooms of the principals and his assistants. At both ends, the speaker and hearer have both hands free. The loud speaking telephone, however, can be put out of use, and an ordinary receiver utilised if necessary. Moreover, an attachment can be fitted to the principal's apparatus and registering calls made during his absence, so that on returning he may ask the relative departments what they wished to speak about.

Among the remaining exhibits to which attention may be called is the Pawlplug, to which we referred in connection with the Building Trades Exhibition at Olympia, a short time ago. There are also a number of exhibits of electric signs. The Elliott addressing machines exhibited by the Hayward Company, 62, Red Lion-street, are shown fitted with electric motors, and the British Tabulating Machine Company, of 2, Norfolk-street, W.C., replace some of the mechanical operations in other tabulating machines by electrical working.

The Magneta Time Company, Ltd., of 14-16, Carteret-street, Westminster, exhibit their electrically-operated clocks, which can be installed on a rental basis. A recent order is for 44 clocks on this system for the Air Ministry's office in Kingsway. Most systems of time recording by electricity depend on batteries, intermittent currents and the maintenance of clear mechanical contacts. In the magneta system the battery is replaced by an alternator, and the circuit is never broken. The alternator is worked by the mechanical energy of the falling weight of a master clock. Every minute this weight falls a fraction of an inch, and by so doing turns the armature of the alternator in a strong magnetic field, and generates an electric current which passes through the whole circuit and propels every minute hand of every secondary clock in the circuit to the next minute. There is no difficulty in doing this through 50 miles of line and working 500 clocks.

For the rest, the exhibition contains a vast amount of interest in the way of office furniture, filing systems, adding and calculating machines, &c.

Milliampere Meter for the Blind.



A clever adaptation of a standard milliammeter was recently made by the General Electric Company. In connection with electro therapeutics a milliammeter was required which could be conveniently used by the blind to enable them to measure or maintain a definite value of current. An instrument, which reads from 0–50 milliamperes, was provided with an external arm moving over an embossed scale with the calibration similar to the instrument scale. Attached to the movable arm in the interior of the instrument are two contacts, either of which make electrical connection with the pointer of the instrument. When in use the arm is set at the reading desired and by means of a clear-toned bell ringing when the pointer is touching one contact, and a muffled-toned bell ringing when touching the other, the operator is able with a regulating resistance to obtain any desired current. On the other hand, if it is desired to read the current flowing the instrument is placed in circuit with the movable arm set at zero, and as soon as the current is switched on the clear bell commences to ring, and continues to do so until the operator swings over the arm beyond the position of rest of the pointer; the muffled bell then rings, and by a nice adjustment of the movable arm a position can be obtained in which neither bell will ring, when the reading can be taken from the embossed scale. The General Electric Company, Ltd., are well known as manufacturers of moving coil and moving iron instruments of all kinds, and the example of special work cited demonstrates how in an emergency exceptional requirements are met.

Water Power Development in Canada.

The Dominion Water Power Branch of the Department of the Interior, and the Dominion Bureau of Statistics of the Department of Trade and Commerce, have just completed an exhaustive census and analysis of the developed water-power in Canada. The figures, which are complete to January 1, 1920, are exceptionally interesting, and are indicative of the manner in which the water-power resources of the Dominion are being utilised. Practically every great industrial centre in Canada is now served with hydro-electrical energy, and has within easy transmission distance ample reserves of water-power. Active construction in hydro-electrical enterprise is fast linking up the few centres which are still unserved and which have water-power resources in their vicinity. In those localities where water-power is not available, Nature has bountifully supplied fuel reserves of coal, gas or oil. According to a recent computation, the water-power resources of the British Empire have been placed at from 50 to 70 million horse-power, and to this total Canada contributes about 20 million horse-power. The latter figure represents the power available at sites about which more or less definite information is available.

According to the statistics just compiled, there is installed throughout the Dominion some 2,418,000 turbine or water-wheel horse-power, of which 2,215,000 H.P. is regularly employed in useful work. The larger figure includes the total installed capacity at full gate, including reserve units. It does not, however, include hydraulic exciter units. A large number of the plants now operating are designed for the addition of further units as the market demands. The ultimate capacity of such plants, together with that of new plants now under construction, total some 3,385,000 H.P. Of the total power installed, 1,756,791 H.P., or 72·7 per cent., is installed in central electric stations—*i.e.*, stations engaged in the development of electrical energy for sale and distribution. Central station power is sold for lighting, mining, electro-chemical and electro-metallurgical industry, milling and general manufacturing. In the pulp and paper industry, 473,265 H.P. is utilised, of which 381,631 H.P. is generated directly from water in pulp and paper establishments, while 91,634 H.P. is purchased from hydro central electric stations. Hydro power used for other purposes and other industries may be listed as follows: For lighting purposes, 434,613 H.P.; in mining, 177,728 H.P.; in flour and grist mills, 42,736 H.P.; in lumber and saw mills, 37,918 H.P.; in other manufacturing industries, 172,955 H.P. These figures are evidence of the widespread manner in which the Dominion's water-power resources are being applied to the furtherance of its industrial development.

The water wheels and turbines installed represent a total of 2,417,896 H.P., or 3,370 units of an average capacity of 715 H.P. While 2,244 of these units are of 100 H.P. or under, they contribute only 82,204 H.P., or 3·4 per cent. of the total; but 1,845,427 H.P. (or 16·3 per cent. of the whole) is contributed by units of 2,000 H.P. and over; 1,391,025 H.P. (57·6 per cent.) by units of 5,000 H.P. and over; 1,029,900 H.P. (42·6 per cent.) by units of 10,000 H.P.; and 160,000 H.P. (6·6 per cent.) by units of 20,000 H.P. and over. These figures illustrate the modern tendency towards the installation of large units. Reference might be made in this connection to the 50,000 H.P. turbines which are contemplated for the new development of the Hydro-electric Power Commission at Queenston.

The central station industry has made great strides in Canada in recent years. A network of transmission systems, which are being rapidly extended from year to year, covers central and south-western Ontario and southern Quebec. Other systems established in numerous centres from coast to coast are likewise rapidly extending their scope. Of the primary power used in the central stations throughout the Dominion, 91·4 per cent. is derived from water, evidencing in a striking manner the advantageous location of the water-power resources to industrial centres. The total installed water wheel and turbine horse-power in hydro central stations is 1,756,791 H.P. Fuel auxiliaries installed as stand-byes to these hydro stations brings the total installed primary capacity up to 1,873,989 H.P. connected to 1,449,180 k.v.a. dynamo capacity. The total capital invested in these central stations (inclusive of transmission and distribution systems) is $369,464,961, or an average of $210 per installed primary horse-power.

Of special interest to engineers is the actual cost of construction of hydro-electric power stations, exclusive of transmission and distribution systems. The figures of 70 representative hydro-electric stations, with an aggregate turbine installation of 745,797 H.P., show a total construction cost at the power site of $50,740,468 (pre-war figures), or an average of $69·11 per horse-power. This figure includes the capital invested in the construction of dams, flumes, penstocks and all hydraulic works, and of power stations and equipment; but it excludes real estate and transmission and distribution equipment. With a water-power development of 274 H.P. per thousand of the population, Canada stands well in the forefront in respect to availability and utilisation of hydro-power resources, being only surpassed in this respect by Norway. The enormous water-power reserves still untouched form a substantial basis for the progressive exploitation and development of other natural resources, and, if properly co-ordinated with the utilisation of the enormous fuel resources of the Dominion, are an assurance of continued industrial expansion and prosperity.

Parliamentary Intelligence.

Opposition having been withdrawn, the Derwent Valley, Calver & Bakewell Railway Bill is proceeding as an unopposed measure.

Among the draft Provisional Orders lodged at the Scottish Office are three which relate to tramways. The Dumbarton Burgh and County Tramways Order seeks to amend the existing powers in respect of passengers' fares and of the rates for parcels. The Order provides for a fare not exceeding 2d. per mile being charged, but the Company will be empowered to issue to artisans, mechanics, factory operatives, and daily labourers return tickets available on the day of issue at the single journey rate.

The Falkirk and District Tramways Order has the same object in view; and the Lanarkshire Tramways Company seek authority to convert the existing £10 shares into new ordinary shares of £1 each. It is also proposed that the basis on which the tolls and charges shall be altered, and that the Company may provide and use omnibuses in extension of their tramway system.

The Halifax Corporation Bill, which authorises the construction of additional tramways, &c., has been passed by a Select Committee of the House of Commons. It is proposed to construct a route to Elland via Elland Wood Bottom and extending the service from Hebden Bridge another stage towards Todmorden. The first of these was opposed by Huddersfield, and the second by Todmorden. Ultimately the Committee agreed to pass the preamble with regard to tramways. The Elland route must be completed within two years and the Todmorden section within three. The proposal to increase the maximum fare to 2d. per mile as well as the powers to supply out-districts with electricity were also approved.

The question of the recent report of the Sub-committee of the Profiteering Committee on the Electric Lamp Industry was again raised in the House of Commons on the 6th inst. In reply to a question, Sir R. Horne said he had consulted the Committee on the subject, and he understood that the evidence upon which they founded their statements regarding the sale of the 1,250,000 half-watt lamps was the evidence of the Association itself. In their findings the Committee stated that "importers and distributors between them made profits on these lamps of something like £280,000 over and above what would appear to us reasonable." In view of the new information furnished by the Association, which indicated that the lamps were sold, not to the public, but to Government departments, controlled factories, shipyards, &c., at a price of about 8s. 3d. each, he understood that the Committee now wished the passage to read as follows: "The importers of these lamps made profits of something like £140,000 over and above what would appear to us reasonable."

Last week a Select Committee of the House of Lords, presided over by the Marquis of Bristol, considered the Bill of the Cardiff Corporation for additional tramway and electricity supply powers. After hearing the evidence the Committee sanctioned the Penarth route and Llandaff and Whitchurch routes, and also the Barry route from Penarth route onward (subject to the consent of Barry Urban Council) and the Newport route (subject to the consent of the Monmouthshire County Council), the consent not to be unreasonably withheld, the Ministry of Transport to decide in case of disagreement.

As to the clause enabling the Corporation to sell electrical fittings as well as to let them on hire, it was pointed out that at present, if they wanted to sell such fittings, they would have to do so, not to the consumer direct, but through an independent person. The Committee decided in view of last year's Electricity (Supply) Act that the Corporation should be content with the clause in that Act.

The Local Legislation Committee of the House of Commons have passed the tramway and omnibus clauses of the Rhondda Urban Council Bill. The Council are the tramway authority and lease the tramway to a local company, and the present Bill authorises various extensions, and also to run motor omnibuses. The Council obtained powers for the construction of new tramways, but it had been impossible to do anything during the war, and the trams were even more urgently required now than they were in 1915. The tramway company undertake to run the omnibus services at their own risk for 12 months, but if there is a loss on the working and the Council require the service continued, the Council are to guarantee to repay any loss up to £800 per annum. Mr. W. B. Cownie, general manager of the Rhondda & District Tramways Company, gave details of the financial arrangements between the Council and the company, and said in about 30 years the whole tramway undertaking would become the property of the Council without any further payment. He was asking for an increase in fares to be sanctioned, because up to the present there had been no dividend for the ordinary shareholders. The Ministry of Transport suggested that there should be workmen's fares of single fare for the double journey, but it could not be done.

On Tuesday, a Select Committee of the House of Commons commenced the consideration of the London Electric Railway Company's (Fares, &c.) Bill, which proposes to increase the maximum fares and charges of the London Electric, Metropolitan District, City & South London and the Central London railway companies, and to amend and repeal certain provisions as to workmen's trains. The London County Council and several Urban Councils presented petitions against the Bill.

Mr. Lloyd, K.C. (for the promoters) asked for an adjournment, as the report of the Minister of Transport was only received on Saturday. The points raised in that report were very serious, and they appeared to differ materially from those covered by the instruction of the House to the Committee. The report came as an absolute surprise; it suggested that the utmost the Committee should do, if they felt inclined to do anything, was to grant some temporary powers, and that the whole matter should be referred to the Minister of Transport, in order that he, acting with the Advisory Rates Committee, should decide.

The Committee agreed to adjourn until after Whitsun.

Electricity Supply in British East Africa.

In our issue of September 27, 1918, we published a short account of the Ordinance which had been prepared by Mr. James McBlain, the Electrical Adviser of the Government of the East African Protectorate laying down the regulations for the supply of electricity in that country, and in our issue of December 19, 1918, we gave an account of Mr. McBlain's reply to the objections which had been raised.

So great has the opposition been in fact that Mr. E. W. Cowan was requested by the London Chamber of Commerce to interview the Protectorate Government in the interests of various estate owners. Mr. Cowan published a memorandum setting forth these objections in the "East African Standard" of February 7, 1920, and has sent a summarised copy of the objections to the "Electrical Times."

He points out that the ordinance practically forbids joint user of electric power, *i.e.*, two or more settlers with adjacent estates may not combine to obtain their power supply from a single generating station on one of the estates. This method, although in general use in the Protectorate at the present time, is only allowed when the estate upon which the generating station is erected obtains a licence for the supply of electric power under which he would be subject to all the obligations applying to a public supply works. The compelling of private settlers to become public suppliers of electric power is therefore likely to act as a deterrent to the use of electric power.

The Ordinance drafted requires existing installations to conform within a certain period to the conditions of the Ordinance as regards standard system, pressure, &c. Owners will, therefore, be required to reconstruct their plant at their own expense.

Existing installations are also to be subject to the conditions of the Ordinance as regards safety to the public, which is, of course, only right and proper, but they will also be subject as regards the terms of their agreements with those who are taking their supply, the manner, form and auditing of their accounts, the testing and certifying of meters and the insuring of a regular and sufficient supply of electrical energy. These conditions are, Mr. Cowan thinks, not right and proper in case of purely private supply. Further, existing agreements must not be renewed, so that if the owners desire to have their joint supply continued they must ultimately apply for a licence.

No departure from the methods of charging specified will be allowed which are not based upon factors which influence the cost of supply. The demand factor is not permitted to be interpreted in terms of price.

The ordinance makes conformance with British Engineering Standards Committee's rules obligatory. This Mr. Cowan thinks is a mistake in a new colony, as it must limit the market from which machinery can be purchased and rule out much second-hand plant. Altogether, according to Mr. Cowan much of the Ordinance draft is too elaborate and complicated for a new country, and it should be replaced by a simpler measure.

Commercial Topics.

British Goods for Spain.

An important exhibition of British manufactures, which is being organised by the Federation of British Industries, will be held at Madrid from June 15 to July 15. There is a very good demand for British goods, but particularly for electrical, agricultural and textile machinery of all kinds, electric motors, lamps and fittings, cables and wires, machine tools, steel tubes, motor cars, &c., and efforts are being made to make the exhibition a good and representative one.

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German Machinery for France.

H.M. Commercial Commissioner at Berlin has issued an interesting report on German industrial conditions. It appears that inquiries were recently made as to the ability of German manufacturers of portable steam engines, motors, cranes and agricultural machinery to supply the French market, and the report is based on replies to these questions. It is stated that portable steam engine manufacturers suffer from lack of tin and copper, and there is also a shortage of varnish for painting the engines. The Board of Trade "Journal" states that the two chief German firms for low-power portable steam engines (up to 60 H.P.) can deliver in four to five months, while the higher power machines (300 H.P. and upwards) take about nine months to complete. Deliveries would be much better but for coal shortage. Subject to the above terms, portable motors and engines of all kinds, including Diesel and ship motors and electric light plants, could be produced in fairly large quantities in Germany, but any part which would normally be made of copper or any metal which Germany has to import would, under present conditions, be of inferior quality. For this reason foreign customers when placing orders for such engines and motors in Germany often supply the raw material of which there is a shortage. The agricultural machinery industry is overloaded with orders and production is only hampered by lack of coal. The chief customers appear to be Denmark and Sweden, and probably Russian agents have placed fairly large orders. It is stated that only four German factories seriously come into consideration for the manufacture of crane navvies, excavators, &c., and that their output has been practically cornered by the Dutch, who always have an enormous demand for this type of manufacture.

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The New Australian Import Duties.

The following are amongst the import duties imposed by the new Commonwealth Tariff, which came into provisional operation on March 25 last. The duties are classified under (*a*) the British preferential tariff, (*b*) the intermediate tariff, and (*c*) the general tariff, and the former duties under (*a*) the British preferential tariff and (*c*) the general tariff are given where possible in parentheses :

Electric machines and appliances, dynamos, transformers and induction coils and electric fans, (*a*) 30 per cent. ad val., (*b*) 35 per cent., (*c*) 40 per cent., (*a* 25 per cent. ; *c*, 30 per cent.) ; regulating, starting and controlling apparatus for all electrical purposes, including distribution boards and switchboards, n.e.i., (*a*) 30 per cent., (*b*) 35 per cent., (*c*) 40 per cent. (*a*, 20 per cent. ; *c* 30 per cent.) ; electric fittings wholly or partly metal, switches, fuses, and lighting arresters, n.e.i., (*a*) 30 per cent., (*b*) 35 per cent., (*c*) 40 per cent. (*a*, 20 per cent.; *c*, 30 per cent.): electric heating and cooking appliances, (*a*) 30 per cent., (*b*) 35 per cent., (*c*) 40 per cent. (*a*, 10 per cent. : *c*, 20 per cent.) ; electrical and gas appliances, telephones, telephone switchboards, telephone distributing boards and appliances, (*a*) free. (*b*) 5 per cent., (*c*) 10 per cent. (*a*, free ; *c*, 10 per cent.) ; electroliers, pendants and brackets, (*a*) 35 per cent., (*b*) 40 per cent., (*c*) 45 per cent. (*a*, 25 per cent. ; *c*, 30 per cent.) : metal filament lamps, (*a*) 1s. per lb., (*b*) 3s., (*c*) 4s. (*a*, 15 per cent. ; *c*, 25 per cent.) ; electrical and gas appliances, n.e.i., not included under brasswork, &c., for general engineering and plumbing and other trades, (*a*) 27½ per cent., (*b*) 35 per cent., (*c*) 40 per cent. (*a*, 20 per cent. ; *c*, 25 per cent.). Electrical articles and materials : Arc lamps, covered cable and wire (except cotton covered), electric vacuum tubes, measuring and recording instruments, (*a*) free, (*b*) 5 per cent., (*c*) 15 per cent. (*a*, free ; *b*, 10 per cent.) ; cable and wire, cotton covered, (*a*) 25 per cent., (*b*) 30 per cent., (*c*) 40 per cent. (*a*, free ; *c*, 10 per cent.) ; carbon manufactures of all kinds, including carbon blocks, (*a*) 30 per cent., (*b*) 35 per cent., (*c*) 45 per cent. (*a*, free ; c, 10 per cent.). Miners' safety lamps, (*a*) free, (*b*) 5 per cent., (*c*) 10 per cent. (*a*, free ; *c*, 10 per cent.). Vehicles, n.e.i., (*a*) 35 per cent., (*b*) 45 per cent., (*c*) 55 per cent. (*a*, 35 per cent. ; *c*, 40 per cent.) ; parts of vehicles with self-contained power propelled by petrol, electricity, &c., single-seated bodies, (*a*) £30 each, (*b*) £35, (*c*) £40 (*a*, £15 ; *c*, £17) ; double-seated, (*a*) £50, (*b*) £55, (*c*) £60 (*a*, £21 ; *c*, £24. 10s.) ; bodies with canopy tops, (*a*) £65, (*b*) £70, (*c*) £75 each or ad val. (*a*) 40 per cent., (*b*) 50 per cent., (*c*) 55 per cent. (*a*, £36 ; *c*, £42). Instruments for measuring absorption, intensity, &c., of light, (*a*) free, (*b*) free, (*c*) 20 per cent.(*a* free ; *c*. free) ; Cautery battery and appliances and X-ray apparatus, (*a*) free, (*b*) 10 per cent., (*c*) 20 per cent. (*a*, free ; *c*, free).

The Tariff is at present under consideration by the Commonwealth Parliament and efforts are being made to increase the preference to British manufacturers There is a general feeling in favour of this step, for at the recent annual meeting of the Australian Association of British Manufacturers and their representatives, held at Melbourne, the president (Mr. R. W. Knox) referred to the important development of local industries during the war period ; it was realised that many articles which had been allowed into Australia either on the free list or subject to a low rate of duty would not continue to enjoy these conditions. It was felt that preferential rates of from 20 to 30 per cent. must be granted to British goods : and representations on the matter had already been made to the Government. It was resolved that the activities of the Association be primarily directed towards securing a strong British preference.

Electricity Supply.

Woolwich Borough Council has decided to adopt electric lighting for the roads and houses on the new estate at Kidbrook.

Clacton Urban Council has received sanction to a loan of £9,500 for additional generating plant.

Mr. C. H. Wordingham has been appointed consulting electrical engineer to Skegness Urban Council.

Application has been made by East Ham Corporation for authority to borrow £12,000 for mains and house services.

Oswaldtwistle Urban Council is negotiating with Accrington Corporation for a supply of electricity for lighting and power.

Sheffield Corporation authorised on Wednesday cable extensions and additions to the Newhall-road station at a cost of about £18,000.

Dublin Electricity Supply Committee has applied to the Ministry of Transport for an order increasing the maximum charge allowed for electricity.

The Darwen Spinning Company propose to adopt electric power, and the Electricity Sub-committee is considering the terms upon which supply is to be given.

Portrush Urban Council has applied for a further loan of £1,000 to cover the cost of erecting the electricity generating station, making the total loan for the scheme £16,000.

Blackburn Corporation has authorised the electrical engineer (Mr. P. P. Wheelwright) to act as consulting engineer in connection with the electric lighting of the Blackburn Institution.

As the Newhaven Gas Company has increased the price of gas by a shilling per thousand the Council has asked the L.B. and S.C. Railway Company if they are in a position to supply electric current for public lamps in the town.

Representatives of Blackburn and Darwen Corporations met on the 6th inst., and it was decided to supply current from Blackburn to Darwen as early as possible, the question of laying mains, &c., being left to the respective electrical engineers.

There is a boom in the demand for electric supply in Swansea, and at last week's meeting of the Electricity Committee the engineer (Mr. J. W. Burr) reported the receipt of 56 new applications. A sum of £5,000 is to be spent on extensions of mains.

Burnley Electricity Committee has agreed to give a supply of current to a local mill for driving a 50 h.p. motor, on condition that the firm shall not consume electricity after 4.45 p.m. in the winter if sorequired by the Electrical Engineer.

Wallasey Corporation has been authorised to proceed with its scheme of extensions at the electricity works, estimated to cost about £76,250. During the past year 367 new consumers were connected, bringing the total to 5,584, and there are several awaiting connection.

The Electricity Commissioners have sanctioned the borrowing by Wolverhampton Council of £40,000 for the purchase of plant from the Ministry of Munitions. The Corporation have agreed to increase the salaries of the borough electrical engineer (Mr. S. T. Allen) by £200 and that of the tramways manager (Mr. C. O. Silvers) by £50.

The Electricity Commissioners have decided that Hove Corporation shall take electricity in bulk from Brighton Corporation, instead of extending its own station. It will be remembered that Hove purchased the local company's undertaking in 1913 for £180,000, and it is estimated that a sum of £30,000 will now be required for converting plant.

Bolton Electricity Committee has instructed the boro' Electrical engineer (Mr. W. J. Wood) to report upon a request from Bolton Chamber of Trade to introduce a differential rate for Electricity for Shop Illumination, as the members think that there should be a lower charge than for general domestic lighting.

For some time we have only been able to record increased charges for electricity, but it is pleasant to be able to give one instance of a reduction in prices. Marylebone (London) Borough Council has reduced its charges by 12½ per cent. The reduction, however, only applies to the March quarter, and includes the allowance due to the reduction of 10s. per ton in the price of coal.

At a meeting of representatives of local authorities at Preston, the delimitation of an area under the Electricity (Supply) Act was considered, and it was decided to form a separate Electricity District for Mid-Lancashire, including the areas of the following authorities : Accrington, Bacup, Blackburn, Blackpool, Burnley, Colne, Darwen, Haslingden, Nelson, Preston, Rawtenstall, Brierfield, Fleetwood, Lytham, St. Annes and Whitworth.

Ayr Corporation has asked the Electricity Commissioners for authority to put in additional generating plant or to erect a new station to enable it to meet the demands of the community. Filing that, the Commissioners are to be asked to approve of Ayr entering into an agreement with Kilmarnock Corporation to take a supply in bulk, or possibly a Joint District Board might be established, on which Ayr and Kilmarnock would have representatives.

The estimate of the cost of the extensions at the Burnley electricity works (£75,000), which was prepared in October last, will have to be increased owing to the advances in the cost of labour and materials. The Council are, therefore, recommended to augment the amount of the borrowing powers from £75,000 to £150,000. The Corporation has made an application to the Electricity Commissioners for an Order permitting the supply of electricity in bulk to Colne.

Ammanford Urban Council has received a report from their consulting engineer, Mr. Arthur Ellis, on the proposal to purchase the local electricity undertaking of Mr. William Herbert, and, with one dissentient, it was agreed to carry out the purchase at £14,375. Mr. Ellis states that the station is in an excellent position, and at present there is a substantial revenue and a good profit. The Llanelly Electric Light Company will be in a position to extend their high-tension main to the Ammanford boundary at an early date, and, if necessary, a supply in bulk will be available.

Messrs. Harland & Wolff have informed Belfast Corporation that they can have the use of two buildings in Queen's-road and Musgrave Channel-road, pending the erection of the new electricity station, and, if necessary, the firm will lend and erect the boilers and adopt the buildings for the purpose. The Electricity Committee is under an obligation to give Messrs Harland & Wolff power as soon as possible, and it has passed a vote of thanks to Lord Pirrie for his generous action. which will enable it to put in one of the 6,000 kw. sets, and give the necessary power both to Messrs. Harland & Wolff and the general public by next November.

Dundee Corporation has not abandoned the Tummel water-power scheme, and inquiries are being made of adjoining local authorities as to their attitude. Forfar County Council has expressed approval of the proposal on condition that electricity could be supplied to the county at a ¼d. per unit. Mr. Wm. Smith thinks the scheme would be a great advantage to the county of Forfar, and a great many farmers would prefer to thresh by electricity rather than by oil engine, and Col. W. T. Steuart Fothringham thinks that if Dundee is prepared to deliver electricity at a ¼d. per unit the Forfar people would take it.

A solution of the difficulties of Kirkcaldy Corporation in connection with their electric supply undertaking has been found. A deputation from the Council recently waited upon the Electricity Commissioners and explained that if they were not allowed to extend the existing generating station, the best course would be to sell the undertaking to the Fife Power Company, including distribution rights. The Commissioners recently decided that Kirkcaldy was too small to be allowed to extend its generating station, and that the provision of electricity supply in Kirkcaldy should be in the hands of a body dealing with a very large area. There were four courses open to the town: (1) Sell the whole undertaking to the Fife Company, including distribution rights; (2) take from the Company a supplementary supply and generally to continue the existing generating station to carry out distribution; (3) cease generating ultimately, and take the whole bulk supplying from the Fife Company, the town carrying out the distribution; (4) allow the Fife Company to bring cables into the town and supply power direct to the large consumers. The deputation thought that the only course was the first, but the Commissioners pointed out that if the undertaking was now sold to the Fife Power Company, the price payable would be the existing debt or the cost of the undertaking, less depreciation and sinking fund; and that if later on a joint authority was formed for the industrial part of Fife, the Power Company would be able to resell the Kirkcaldy undertaking to the new authority at a goodwill price, thus making a considerable profit. Confidence was expressed by the Commissioners that in the near future a Joint Electricity Board would be formed for Fife, and they urged the deputation that between now and five years hence the Corporation should put themselves into communication with other authorities in Fife with the view of forming such an authority and taking over the public supply as a county or municipal monoply. They concurred in this view, and the Commissioners undertook to put themselves into communication with the Fife Power Company, leaving the town to follow up and conclude the arrangements. Subsequently, Mr. George Balfour, of the Fife Power Company, agreed to recommend to his Company that a supply as required should be given to the town.

Electric Traction.

The Airdrie and Coatbridge Town Councils have agreed to purchase the local tramways.

The Durham County Council has decided to apply for powers to construct either a tramway or light railway from the terminus of the Gateshead tramways at Low Fell to Chester-le-Street.

Doncaster Corporation has instructed the borough surveyor to submit an estimate of the cost of extending the tramways from the terminus at Hyde Park to the Racecourse via Carr House-road.

The skilled workers of Sunderland Corporation Tramways Department have asked for an annual holiday of eight days, with pay. The committee will make enquiries as to the practice of other tramways in the North before considering the matter.

The recent increase of 10s. a week to tramways employees will cost Bradford Corporation £40,000 a year, and the Tramways Committee has appointed a sub-committee to consider the question of tramway fares in relation to the revenue of the undertaking. The track is also in a bad state of repair, and needs overhauling or relaying, and it is estimated that an increased income of £100,000 per annum is needed to place the undertaking on businesslike lines.

The total income of the Hull Corporation Tramways department last year was £307,151 and the expenditure £315,877, leaving a deficit of £8,726, which will be met out of reserve. Having considered a statement by the general manager (Mr. Rayner) showing the estimated expenditure for the coming year, the Committee has decided to recommend a charge of 1½d. for the existing 1d. stages and 2d., instead of 1½d., for the whole journey. No cars are to be run between 2 and 5 a.m. and half-fares for able-bodied soldiers in uniform have been discontinued.

Miscellaneous.

We are informed that the Labour Dispute at the Enfield Ediswan cable works has been settled and the men returned to work on Wednesday.

The death is also announced of Mr. Edward Noyes, governing director of Noyes Bros. (Sydney), Ltd., a well-known electrical engineering firm.

The Industrial Court has awarded to employees in electric power stations and sub-stations an advance in time or day rates of 6s. per week, or 1½d. per hour, according to the custom of payment on the various railways.

Claims against Edward Wingfield Fuller Heath (trading as Heath, Wingfield & Company), electrical engineer, 6, Hans-road, Brompton-road, London, S.W.1, under a deed of assignment executed by him on March 20, 1920, are to be sent by May 24 to the trustee, Mr. W. A. J. Osborne, Balfour House, Finsbury-pavement, London, E.C.

We are glad to hear that that ever-welcome annual, "Printers' Pie," will be published on Monday, May 17, and, judging by the list of eminent authors and artists who have contributed to its pages, it will undoubtedly come as a cheery gleam. It is published at 6, Great New-street, London, E.C., and can be obtained at all booksellers' and bookstalls at 1s. 6d.

The death is announced of Mr. Edward Bull, the last survivor of the party who laid the first Atlantic cable between Great Britain and the United States. For many years he was superintendent of the Eastern Telegraph Company's station at Porthcawl. Mr. Bull was 90 years of age.

About 200 labourers engaged in cable laying by the Leeds Electricity department ceased work last week as a protest against the failure to bring them under award numbered 870, applying to the engineering and allied trades. The strikers claim under the award 5s. per week arrears since Dec. 1 last.

On behalf of the workers in the engineering and foundry, shipbuilding and chemical trades application has been made to the employers' association for an Advance in Wages Rates to general workers (both men and women) as follows:—Adults, £1 per week; juniors (under 18 years of age), 10s. per week; piece-workers, an equivalent percentage increase. For workers 18 years of age and under 21 who are doing adult work, adult pay is claimed.

As certain electricity undertakings are not carrying out the recommendations of the Joint Council, the employers' side of the Home Counties Industrial Council (No. 9 area) has passed a special resolution that "supports any action that the Trades Union side of the Council decide to take in order to bring defaulting undertakings into line in conforming with the Resolution of Council of March 31, granting an advance of 3s. per week be paid to all employees by electricity supply undertakings in the area as from April 1, 1920, since by the action of such undertakings in not carrying out the recommendations the matter of fixing basic rates is being delayed, and further the antagonistic attitude thus indicated disturbs the whole of the relation between employers and employed." A special letter has been forwarded to Gillingham Corporation, which had decided not to follow the recommendations of the Industrial Council. As we go to press we learn that Gillingham Corporation has agreed to pay the advance of 3s. referred to above.

In a literary advertisement in a recent issue of "The Times" a Norwegian engineer, Mr. Ragnvald Blakstad, puts forward a scheme for revolutionising this country by providing it with Abundant Electric Power for all purposes. His idea is that the State should form a power company, with a nominal capital, and make an issue of guaranteed power bonds. Twelve to 15 stations would be erected, each of a capacity from 125,000 to 250,000 kw., which would cost, at £30 per kilowatt, £90,000,000 Eight hundred miles of transmission line would cost £50,000,000, and by-product plant erected in connection with the stations £62,500,000. Basing his estimates on coal at 15s. per ton, he considers that the cost of generation would be 0·15d. per kilowatt-hour. Distribution costs would amount to 0·2d. per kilowatt-hour, so that the total cost of delivering current to consumers would be not more than 0·35d. per unit. By this arrangement, he thinks there will be a saving of some 5,000,000 tons of coal, and a saving in labour of some 90 per cent. The scheme is interesting, but the object in putting it forward at the moment is not quite clear.

Institution Notes.

The annual general meeting of the Institution of Electrical Engineers will be held on Thursday, May 20, at 5.30 p.m., at the Institution of Civil Engineers. The annual general meeting of the Benevolent Fund of the Institution will also be held on the same day at 5 p.m.

An interesting and instructive lecture on "Wireless Telegraphy" was given before a large gatherig of members of the National Association of Supervising Electricians and visitors at St. Bride Institute, on May 4, by Mr. Maurice Child, M.W.S.L. The lecture was illustrated by practical demonstrations, and messages were picked up from outside sources by arrangement with the G.P.O.

At a recent meeting of the Wireless Society of London, Major Basil Binyon read a Paper on "An Automatic Call Device," and gave a practical demonstration of the operation of the apparatus. By its use, it is claimed that only one operator need be employed on board ship, the call device being left in circuit at the less busy hours to take incoming signals. If a signal is received, a bell is rung and the operator is called to the instrument.

Tenders Invited.

Lincoln Corporation want tenders by May 24 for coal-handling plant. Specifications from Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, London, S.W.1.

Manchester Electricity Committee require tenders by 10 a.m. May 20 for a 40-ton workshop electric crane. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Manchester Electricity Committee require tenders by 10 a.m. May 19 for cable supplies and cable-laying work (33,000 volt). Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Stirling Corporation require tenders by May 19 for electric wiring in 100 houses to be erected under Shiphaugh housing scheme No. 2. Specifications, &c., from the Burgh Engineer.

Manchester Corporation require tenders by 10 a.m. May 20 for the supply and erection of a 40-ton workshop electric crane at Barton power station. Specifications, &c., from Mr. F. E. Hughes, Town Hall.

Colwyn Bay Urban Council invite tenders for h.t. Feeder Cables, Rotary Converter and Static Transformer (or Motor Converter Equipment) and Switchgear. Specifications from the Electrical Engineer, and tenders to the Clerk by noon May 15.

Hammersmith (London) Borough Council invite tenders for supply of two 10,000 kw. Turbo-alternators with condensing plant. Specifications from the borough electric engineer (Mr. G. Gilbert Bell), and tenders to the Town Clerk by May 21.

Manchester Electricity Committee require tenders by June 7 for supply and erection at Barton power station of 33,000 volt and 6,000 volt main switchgear, pressure testing switchgear, &c. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Belfast Corporation invite tenders for the manufacture and erection at the East Bridge-street electricity works of coal handling plant. Specifications from the city electrical engineer, Mr. T. W. Bloxam, M.I.E.E., and tenders to the Town Clerk by May 19.

Leeds City Council invite tenders for a steam turbine, three-phase alternator and exciter of 1,200 kw. capacity or thereabouts. Specifications from the manager of the electricity department, Mr. C. Nelson Hefford, 1, Whitehall-road, Leeds, and tenders to the Town Clerk, 26, Great George-street, Leeds, by 11 a.m. June 14

Hackney (London) Borough Council invite tenders for four water tube boilers, induced draught plants and fuel economisers, one 10,000 kw. turbo-alternator and exciter, surface condensing plant, two circulating motor driven pumps, E.T.H. switchgear, &c. Specifications from the borough electrical engineer, and tenders (by 7 p.m., June 9) to the Chairman of the Electricity Committee.

Tenders are invited (by June 16) for the supply to the Postmaster General's Department, State of Western Australia, of telegraph and telephone instruments and parts as per schedule 680, and also (by July 14) for the supply and delivery of telegraph and telephone instruments, &c., as per schedule 674. Tender forms, &c., from the office of the High Commissioner, Room 406, Australia House, Strand, London, W.C.2.

Personal and Appointments.

The salary of the Rochdale tramways manager (Mr. G. Webster) has been increased from £600 to £800 per annum.

Dundee Corporation has increased the salary of the city electrical engineer (Mr. H. Richardson) from £1,000 to £1,150.

The salary of the Leeds City electrical engineer, Mr. C. N. Hefford, has been increased from £1,260 to £1,500 per annum.

Walsall Corporation have appointed Mr. Charles Burgess, general manager and engineer of West Hartlepool Corporation tramways, as manager of the Walsall tramways department, at a salary of £700 per annum, rising by annual increments of £50 to £900.

Mr. C. L. Black, mains superintendent, has been promoted to the position of assistant engineer of the Glasgow Electricity Department, and Mr. R. B. MacCall becomes secretary and treasurer.

Mr. S. G. Castle Russell has now retired from the control of the electrical inspection department of the Phœnix Assurance Company, and is retained by the company for purely consultative work. His address will be, as hitherto, No. 17, Sherborne-lane, King William-street, E.C.

Mr. E. B. Hunter, A.M.I.E.E., succeeds Mr. Castle Russell as electrical engineer to the Phœnix Assurance Company.

Mr. Scott-Taggart, lately in charge of the wireless valve department of the Edison Swan Electric Company, Ltd., has resigned in order to take up a more important position with the Radio-Communication Company, Ltd. His technical services in connection with matters relating to thermionic valves will at present be at the disposal of the Edison Swan Electric Company when required.

Business Items, &c.

Messrs. John F. Raworth & Moss, consulting engineers and patent agents, have removed to 75, Victoria-street, Westminster, S.W.

The offices of the Rugby Engineering Society have been removed to 10, Elborow-street, Rugby.

The English Electric Company, Ltd., has taken over the local branch of Dick, Kerr & Company, at Balcarce 278, Buenos Ayres.

Wm. P. St. John and Hy. Ashdown (trading as Sinclair, Paget & Company), electrical engineers, 8, New Inn-yard, Shoreditch, London, E., have dissolved partnership. Debts by Mr. St. John.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1918 Specifications.

119,868 Angus. Apparatus for electrically controlling railway trains or vehicles through the track. (10 10 17.)

140,835 Marsh. Treatment of metals and refractory materials and of tools or crucibles made thereof and the electric furnaces used therefore. (4 7 18.)

140,853 Calverley & Highfield. Apparatus for converting alternating currents to direct currents and vice versa. (29 11 18.)

140,856 Coventry Electric Clock Co. & Rushton. Electric clocks. (30 12, 18.)

1919 Specifications.

133,970 Metropolitan Vickers Electrical Co. Balancing means for polyphase electric current systems. (17/10 18.)

Relates to a polyphase electric current system in which unbalanced polyphase E.M.F.'s tend to be produced, these E.M.F.'s being resolved into a major balanced component and a minor balanced component of opposite phase sequence, a polyphase balancing machine having its primary windings respectively connected in series in the conductors between the source and point of consumption of electrical energy, said machine being rotated in such a direction that it sets up a synchronous impedance to said minor component without substantially affecting said major component, whereby said minor component is largely suppressed and only said major component permitted to function.

137,308 Angus. Apparatus for electrically controlling railway trains or vehicles through the track. (10/10/17. Divided application on 119,868.)

139,146 Glacoma. Devices for the prevention of unauthorised taking-off of current from electric conductors. (18 2 19.)

140,655 Automatic Telephone Mfg. Co. & Ray. Automatic or semi-automatic telephone systems. (23 5/19.)

140,656 B.T.-H. Co. (G.E. Co.) Electrical systems of power transmission. (23 5 19.)

140,661 Ames & Gilinson. Electric coils. (28/5 19.)

140,675 Tucker. Composition for insulating & waterproofing electrical elements. (28 6 19.)

140,693 Clifford of Chudleigh (W. H. Clifford), Baron. Dynamo-electric machines. (27 8 19.)

140,705 Goldstone. Electric induction coils for medical purposes. (19/9/19.)

140,864 Compare & Pizzi. Tracker devices for electric piano-players. (18 1 19.)

140,868 Arese. Electric heating apparatus. (23 1 19.)

140,903 Morris. Electric lighting systems as used on motor vehicles. (1/4 19.)

140,913 Scott & Pollock. Current-collecting devices for dynamo-electric machines. (22/4 19.)

140,936 Bulpitt & Denholm. Improved brush-holder for electric machines. (4 6 19.)

140,970 Belfield. Automatic electric couplings. (5/9/19.)

140,975 Fuller's United Electric Works Ltd. & Gilbert. Holders for incandescent electric lamps. (25/9 19.)

140,986 Dunn. Means for obtaining electrical energy from the atmosphere. (4 11 19.)

1920 Specification.

141,002 Angus. Apparatus for electrically controlling railway trains or vehicles through the track. (10 10 17. Divided application on 119,868.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

December 9, 1919.

30,744 Archibald. Balancing voltages in three-wire direct-current system by means of static balancers.

30,745 Glanvill. Direct-current dynamos.

30,771 Runbatten. Distributors for electric current for use with internal combustion engines.

30,797 Fabrik Elektr. Apparate F. Sauter. Controlling devices for electrically wound clockwork, &c. (24 12/18, Switzerland.)

30,799 Le Tall. (Westinghouse Electric & Mfg. Co.) Circuit interrupting devices.

30,800 Western Electric Co. Signal transmitting mechanisms.

30,843 Round. Thermionic amplifiers.

30,851 Henn. Electrical engine starting devices.

30,857 Townley. Electric burglar alarm fitted to locks.

30,868 Clark. Electrical static machines and apparatus for electro-therapeutic work, &c.

December 10, 1919.

30,881 Vogel. Automatic electric light switches.

30,922 Metropolitan Vickers Electrical Co. & Palmer. Protective devices for alternative-current systems.

30,941 Claremont. Devices for securing electric fittings.

30,943 Suchostawer. Dynamo-electric machine.

30,957 Paratore. Obtaining variable speeds in alternating-current motors.

30,961 Bull. Electrical signalling apparatus for railways.

30,970 Hulfish. Automatic telephone systems. (8/12/17, U.S.)

December 11, 1919.

31,002 Mordey. Electro-magnetic engines or motors.

31,005 Barker. Wireless telegraphy systems of the arc gap type.

31,014 Brown & Rowley. Motors.

31,045 Colquhoun. Holders or containers for electric heating elements.

31,059 Lundberg & Pegg. Electric switches.

31,064 Bryd n. Wireless telegraphy, &c.

31,066 Skinningrove Iron Co. & Bury. Apparatus for electrostatic deposition particles from gases.

31,088 Wade. (Coto Coil Co.) Electric coils.

December 12, 1919.

31 103 Taylor. Methods of distribution on alternating-current systems.

31,155 Monte. Electrically heated thermo-siphon radiators.

31,169 Grosjean. Electric sparking plug. (14 11 18, France.)

31,199 & 31,200 Anous. Apparatus for electrically controlling railway trains through the track. (10/10 17, Sweden.)

31,205 Chitty. Dynamo electric machines.

31,220 Mossay & Co. & Ransomes, Sims & Jefferies. Electrically propelled road vehicles.

December 13, 1919.

31,253 D.P. Battery Co. & Waddell. Storage battery cells, &c.

31,262 C w. Variable cut-off for.

31,263 Gardner. Electric miner's lamp.

31,268 Telephone Mfg. Co. & Murray. Telephones.

31,269 Goldstone. Cable connector boxes.

31,300 Favre-Bulle & Lavet. Acoustic alarms operated by altaernting current.

31,304 Imeson & Hunter. Electrical signallingapparatus for mines, &c.

December 15, 1920.

31,338 Browne. Electric terminals of sparking plugs, &c.

31,345 & 31,346 Erskine Murray & Crowther. Radio navigational apparatus, &c.

31,384 Le Tall. (Westinghouse Electric Mfg. Co.) Electrically-driven sewing machines

31,390 Withers. (Renault.) Electric lighting systems for automobiles, &c.

Companies' Reports, &c.

The directors of Hurst, Nelson & Company, Ltd., have declared an interim dividend of 1s. per share (5 per cent.) on the ordinary share capital.

A dividend of 4 per cent. on the ordinary shares has been declared by the Dudley, Stourbridge and District Electric Traction Company, Ltd.

Mr. C. Jermyn Ford has resigned his seat on the board of the British Electric Traction Company, Ltd., and Mr. J. S. Austen has been elected a director of the company.

Sir Henry E. F. Goold-Adams, K.B.E., late chairman of the Nitrogen Products Committee, and Sir John D. Rees, Bart., M.P., have joined the board of the Low Temperature Carbonisation, Ltd.

The West African Telegraph Company, Ltd., will make an additional payment equal to a dividend of 2 per cent., making a distribution for the past year of 4 per cent., tax free.

The Oriental Telephone and Electric Company, Ltd., has declared a final dividend for the year 1919 of 6 per cent. on the ordinary shares (making a total of 10 per cent. for the year) and a bonus of 2 per cent.

The net profit of the Bastian Meter Company, Ltd., for the past year was £976, and with £151 brought forward the total is £1,127. The directors recommend payment of the 6 per cent. dividend on the cumulative preference shares for the two years ending Dec. 31, 1919, and also a dividend of 3 per cent. on the ordinary shares for the year 1919, carrying forward £589.

The revenue of the London & Suburban Traction Company, Ltd., for the past year amounted to £37,395, compared with £46,294 in 1918. Adding £7,093 brought forward and deducting expenses (including debentures and loan interest) and providing for sinking fund charges upon the 5 per cent. debenture stock, there remains £1,205 to be carried forward. Lord Ashfield has rejoined the board, and has been elected chairman in place of Lord Stuart of Wortley, who becomes deputy chairman.

The gross profit of the North of Scotland Electric Light & Power Company, Ltd., for 1919 was £6,409, compared with £6,644 in 1918. After meeting interest on debentures and loans (£2,614), writing off £71 from suspense account, making provision for tax on undivided profits (£208) and adding £1,214 brought forward, the balance is £4,729. The directors recommend payment of a dividend at rate of 3 per cent. for year, which will absorb £1,500, that £2,500 be placed to renewal reserve account, and that balance (£729) be carried forward.

The accounts of the London & Lancashire Fire Insurance Company, Ltd., show progress in all departments. The premium income has been increased from £6,252,459 to £6,759,059, and the reserve funds from £5,252,662 to £5,717,582. The capital has been increased to £5,000,000, and resolutions authorising the elimination of the word "Fire" from the name of the company, and the division of each of the shares into five shares of £5 each (£1 paid up), have been passed, subject to confirmation at a meeting to be held on the 25th inst.

The directors' report of the Northern General Transport Company, Ltd., for 1919, states that the total capital expenditure on the motor omnibus undertaking on Dec. 31 last, amounted to £73,506, an increase during the year of £30,631, mainly due to the increase in the fleet. The gross traffic receipts show an increase, chiefly due to the larger number of vehicles in service, but the costs of operation continue to rise rapidly, and a further increase in fares was made on the 1st inst. The investments of the Company in Gateshead and District Tramways, the Tynemouth and District Electric Traction and the Jarrow and District Electric Traction Companies stand at £438,706. The traffic receipts (less working expenses), dividends and other revenues for the year amounted to £44,174. After providing for administration expenses, deducting £2,468 for loan and debenture interest, and providing £2,226 for renewals, there remains £36,558, with £7,946 brought forward, the divisable surplus is £44,504. The directors recommend a dividend at rate of 6 per cent. on the preference and 10 per cent. for the year on the ordinary shares, leaving £14,010 to be carried forward.

The revenue of the Potteries Electric Traction Company, Ltd., for the year 1919 amounted to £271,309. Traffic and parcel receipts were £252,438, an increase over 1918 of £46,304. The expenses also increased by £51,590, although many repairs and renewals have again had to be deferred. After deducting all expenses chargeable to revenue including £11,025 for debenture interest, and £15,000 for renewals, there remains £44,141 compared with £53,561. Adding £12,441 brought forward the balance available is £56,582. The directors recommend that £20,000 be placed to reserve, that a dividend on the preference shares at rate of 5 per cent. per annum (£12,250) and a dividend on the ordinary shares at rate of 5 per cent. per annum (£12,250) be paid, leaving to be carried forward £12,082. The capital expended during the year was £3,903. The expenses have increased very largely, due to repeated advances in wages and the higher cost of materials. The gross receipts have also increased by reason of the higher fares now charged and other causes. Wages continue to advance, and the raising of additional revenue becomes more difficult. The Board during the year negotiated the sale to Stoke-on-Trent Corporation of the undertaking on terms which they were prepared to recommend to the shareholders, but the Bill to confirm the agreement of sale was subsequently withdrawn by the Corporation, as it failed to obtain the approval of the ratepayers.

The Urban Electric Supply Company, Ltd., reports that the gross profit for 1919 was £59,824 14s., compared with £63,889 11s. 2d. in 1918, and after deductig cost of administration, directors' and auditors' fees, &c., the balance is £55,604 7s. The amounts required for interest, debenture stock redemption and income tax absorb £47,998 5s. 1d., leaving, together with £3,716 7s. 1d., brought forward, an available balance of £11,322 9s. The directors recommend that £10,000 be placed to reserve for depreciation and that the balance (£1,322 9s.) be carried forward. In common with other provincial undertakings the directors state that the Company has suffered severely during the past year from its inability to adjust its charges sufficiently to meet the constantly increasing costs of supply, with the result that the profits do not admit of the payment of any dividend. To overcome the difficulty the directors joined with Edmundsons' Electricity Corporation in promoting a Bill to enable the Company to earn a reasonable return on its capital. They regret to report that the Bill was rejected by the Committee to whom it was referred. The directors are now endeavouring to secure the necessary relief by other means.

The usual comparative statement of profits derived from the undertakings is appended. The total load connected in kilowatts at the 13 stations of the Company was 43,299 compared with 39,503 in 1918, and 36,902 in 1917.

Mr. J. G. B. Stone, who presided over the meeting of the Indian Electric Supply and Traction Company, Ltd., last week stated that the units sold by all departments had increased, except under the head of special contracts. Some of the mills had been affected by labour unrest. To give an increased margin of safety they had secured a 500 kw. secondhand set, which was shipped out early this year. Capital expenditure showed an increase of Rs1,78,136. Since the last meeting the directors had made an issue of £120,000 seven per cent. non-cumulative convertible preference and 30,000 ordinary shares for the erection of the new power station and its equipment. The contract had been placed with the English Electric Company, and they might expect shipment of the plant this year. The proposal was to equip the new station at once with two 3,000 kw. sets and to make provision for an extension to 20,000 kw. It seemed probable that the demand would necessitate a large addition to the installation now on order at an early date. The directors looked forward to very considerable developments as the new power house would enable them to supply the growing demands of consumers. The tramway had not proved more remunerative than last year, although there was an increase in the number of passengers carried and an improvement in traffic earnings, but against this they had had to meet very heavy expenditure, particularly on repairs. The directors proposed to pay a final dividend of 6 per cent., making 9 per cent. for the year.

New Companies.

AFRICAN CONCESSIONS SYNDICATE (1920), LTD. (166,966)—Private company. Reg. April 30, capital £5,000 in 2s. shares, to take over the business of the New African Concessions Syndicate, Ltd. (incorporated in 1910), and to carry on the business of an electric light, heat and power supply company, &c. First directors are Major W. A. Wills, A H. D. Cochrane and W. Praeger. Sec., E. S. Briggs. Reg. office: 10-11, Broad-street Avenue, E.C.

ALLIANCE ELECTRICAL COMPANY, LTD. (166,835.)—Private company; reg. April 27, capital £10,000 in £1 shares, to take over the business of electricians and electrical engineers, &c., carried on by the Alliance Electrical Company, Ltd. (in liquidation). First directors are W. F. White, H. J. Grant and Elizabeth McArthur. Reg. offices, 32, King-street, Covent Garden, W.C. 2.

ARMATURE WINDING COMPANY, LTD. (166,778.)—Private company; reg. April 24, capital £5,000 in £1 shares, to carry on the business of electric and steam engineers and contractors, suppliers of electricity, manufacturers of tramway, electric and other apparatus, &c. First directors are H. G. Wainscott and G. Marsham. Reg. office, 44a, Bolton-street, Bury.

E. I. C. MAGNETOS, LTD. (187,032)—Private company. Reg. May 3, capital £75,000 in £1 shares, to take over the business of E. I. C. Magnetos, Ltd. (incorporated in 1913), and to carry on the business of manufacturers of magnetos and appliances of all kinds for ignition or starting in connection with internal-combustion engines, &c. Sec., E. C. Cole. Reg. office: Royal Wellington Works, Sampson-road North, Birmingham.

ELECTRICAL INDUSTRIES, LTD. (167,108)—Private company. Reg. May 4, capital £2,000 in £1 shares, to carry on in the United Kingdom, the colonies, India and elsewhere the business of manufacturers of electric fires, lamps, filaments and radiators of all kinds, stoves, meters, &c. E. Woodroffe is first director. Reg. office: 9-10, Pancras-lane, E.C.4.

EVER READY COMPANY (GREAT BRITAIN), LTD. (167,171)—Reg. May 6, capital £500,000 in £1 shares (200,000 7 per cent. cumulative participating preference). To carry on the business of electricians, electrical engineers, manufacturers of and dealers in electrical appliances, apparatus, novelties, &c., and to enter into an agreement with the British Ever Ready Co., Ltd. First directors are C. H. C. Moller, S. Stern, M. Goodfellow, C. H. Dade and A. H. Sheppard (all directors of British Ever Ready Co.).

NORTHERN ELECTRIC VEHICLE SERVICES, LTD. (166,883.)—Reg. April 28, capital £100,000 in £1 shares, to carry on the business of manufacturers, builders, designers, repairers and owners of and agents for electric or other mechanically propelled vehicles, lorries, &c. First directors are G. S. Newall, R. S. Barrett and F. Nicholson. Reg. office, Northumberland-road, Newcastle-on-Tyne.

Forty Years Ago.

(THE ELECTRICIAN, MAY 15, 1880.)

SIR WILLIAM THOMSON presided at the meeting of the Physical Society (of which he is president) on Saturday last.

TOO GOOD TO BE TRUE.—It is said that a M. Parodie claims to have discovered a method of transmitting large quantities of electricity over long distances, distributing it at any number of points as required on the way.

PROF. FLEEMING JENKIN, F.R.S.—The Royal Society of Edinburgh has awarded the Keith medal for the biennial period 1877-79 to the well-known electrician, Prof. Jenkin, for his Paper on the application of graphic methods to the determination of the efficiency of machinery.

THE TELEPHONE AT CHESTER.—The telephone is being gradually introduced by business houses in lieu of messengers from office to workshop. In Chester Messrs. J. Dickson & Sons have established telephonic communication between their chief office in Eastgate and their nurseries at Newton.

CONTACT ELECTRICITY.—M. H. Pellat has devised a new method of measuring the electricity developed by the contact of two metals, which permits of great precision. It is a compensating method, based on the principle that if the two metals are connected by a wire they take the same difference of potential as if directly brought together. M. Pellat breaks the wire at a point, and introduces between the two ends previously joined a graduated difference of potential variable at will, which is made to neutralise the difference due to the metals and give a nil reading. The adjustable difference of potential is got by passing a constant current through a Pouillet rheostat, the resistance between the zero—sliding contact giving the E.M.F. A thousand divisions of the scale correspond to the E.M.F. of a Clark cell. The method gives results to 1·000 of a Daniell cell. The results are that the differences of potential vary with the state of the surfaces and the temperature, metals being more + when the temperature is high and [illegible] when low. These differences also depend on the nature and pressure of the gas surrounding the metals. With copper and zinc, when the pressure of the gas diminishes the difference of potential increases, especially with oxygen, nitrogen and dry air. These differences are, however, slight.

THE ELECTRIC LIGHT AT WOOLWICH.—Among the interesting results springing from the great docks at North Woolwich will be a most complete exhibition of the value of the electric light for dock and harbour purposes. The London Light Company have, by permission of the London and St. Katherine Docks Company, erected along the entrance of the existing Victoria Docks several lamps, so as to show the special characteristics and power of their systems; and the Anglo-American Electric Light (Brush Light) Company have also, it is said, obtained the sanction of the Company to exhibit their light within its premises; but the new Victoria Dock is that which will chiefly claim attention, the company having contracted with Messrs. Siemens Brothers for lighting the whole length of this dock and dry docks, with the roads and railways on both sides of them, with the electrical light on the Siemens system. This will be effected with 28 or 30 lamps, each of 6,000 c.p., and each placed at an elevation of from 60 ft. to 80 ft. above quay level. The light will enable work to be carried on by night, in cases of necessity, as well as by day. The same system is, we are informed, arranged for Holyhead Harbour and for Barrow-in-Furness.

Prices of Metals, Chemicals, &c.

TUESDAY, May 11.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£110 0 0	—	—
Electro Wirebars...	,,	£114 0 0	—	—
H.C. wire basis......	per lb.	1s. 3¾d.	—	—
Sheet	,,	1s. 5½d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8¾d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 11½d.	¼d.	—
Sheet, basis	,,	1s. 4¼d.	—	—
Wire, basis	,,	1s. 3¾d.	—	—
Iron—				
Cleveland Warrants	per ton	£10 7 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£48 10 0	—	—
Lead Pig—				
English	,,	£40 0 0	—	£2 0 0
Foreign or colonial	,,	37 15 0	—	£2 5 0
Tin—Ingot	,,	304 10 0	—	£41 0 0
Wire, basis	per lb.	0 3 10¾	—	4¾d.

Salammoniac.—Per cwt. 105s.-100s.
Sulphur (Flowers).—Per ton £21.
,, (Roll Brimstone).—Per ton £21.
Sulphuric Acid (Pyrites, 168°).—Per ton, £8 8s. 9d.
Copper Sulphate.—Per ton £47.
Boric Acid (Crystals)—Per ton £74
Carbon Bisulphide.—Per ton £60
Sodium Bichromate.—Per lb. 9d
Sodium Chlorate—Per lb 5½d
Rubber.—Para fine, 2s. 2½d.; plantation 1st. latex 2s. to 2s. 0¼d. lb
Shellac.—T.N. Orange, 565s. to 570s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

Arrangements for the Week.

FRIDAY, May 14th (to-day).

IRON AND STEEL INSTITUTE.

3 p.m. At Mappin Hall, The University, Sheffield. Papers to be read: "Effect of Initial Temperature upon the Physical Properties of Steel," by Messrs. J. H. Andrew, J. E. Rippon, C. P. Miller and A. Wragg; "The Properties of Iron-Chromium Carbon Steels. Part I., Thermal Analysis," by Messrs. C. A. Edwards, H. Sutton and G. Oshi; Part II., "Effect of Heat Treatment on Electrical Resistivity," by Messrs. C. A. Edwards and A. L. Norbury; "On the Structural Constitution, Hardening and Tempering of High-speed Steel containing Chromium and Tungsten," by Messrs. K. Honda and T. Murakami; "The Structure of some Chromium Steels," by Mr. J. H. G. Monypenny; "The Effect of Various Elements on the Electrical Resistivity of Iron," by Mr. A. L. Norbury; and "Brittleness of Nickel-Chrome and other Steels, Part II.," by Mr. F. Rogers.

PHYSICAL SOCIETY OF LONDON.

5 p.m. At the Imperial College of Science, Imperial Institute-road, South Kensington. Demonstration of Experiments on the Thermionic Properties of Hot Filaments, by Dr. F. Lloyd Hopwood. Papers: "A Modified Theory of the Crookes Radiometer," by Mr. G. D. West; "On the Magnetic Properties of Silicon-Iron (Stalloy) in Alternating Fields of Low Value," by Mr. A. Campbell; "On Tracing Rays through an Optical System," by Mr. T. Smith.

INSTITUTION OF ELECTRICAL ENGINEERS, STUDENTS' MEETING.

7 p.m. At King's College, Strand, London, W.C. Paper on "Electrical Motor Control Devices," by Mr. E. G. Humfress. Annual General Meeting.

JUNIOR INSTITUTION OF ENGINEERS.

7.30 p.m. At 39, Victoria-street, London, S.W. Discussion on "Business Aspect of the Peace Treaty," opened by the Hon. H. Fletcher Moulton.

INSTITUTION OF AUTOMOBILE ENGINEERS.

7.30 p.m. At the Technical Institute, Coventry. Paper to be read on "Cast Iron in Relation to the Automobile Industry," by Mr. J. E. Hurst.

WEDNESDAY, May 19th.

ROYAL SOCIETY OF ARTS.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Electrical Osmosis," by Mr. J. S. Highfield.

THURSDAY, May 20th.

ROYAL SOCIETY OF ARTS, INDIAN SECTION.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Roads and Transport in India," by Brig.-Gen. Lord Montagu of Beaulieu.

INSTITUTION OF ELECTRICAL ENGINEERS.

5.30 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Annual General Meeting.

FRIDAY, May 21st.

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, London, W. Discourse on "The Thermionic Valve in Wireless Telegraphy and Telephony," by Prof. J. A. Fleming, F.R.S.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics":—"Cost of Airship Ton Miles"; "Landing, Run and Take-off of Aeroplanes," by J. Klemin; "Loads and Stresses on Aeroplanes," by J. Case.

"Cabinet Maker":—"Tripod Tables"; "Interior Decoration," by Robert Adam; "Patents: Recent Specifications applying to the Furniture Trades."

"Chemical Age": New Association of Chemical Merchants: special report; and "Industrial Application of Liquid Air and Oxygen."

"Fruit Grower":—"Food Ministry and the Outlook"; "Tasting Day at National Cider Institute"; and "A New Rotary Cultivator."

"Gas World":—"Gas Engine Design"; "Power from Low Grade Gas"; and all the gas news of the week.

"Hardware Trade Journal":—The Ironmongers' Federation at York; Annual Meeting of the Iron and Steel Institute; "Labour Saving in the Foundry (IX.)," by Joseph Horner.

"Ways and Means":—"The American Attitude," by Sir George Paish; "Commercial Aspects of Aviation," by Major P. L. Holmes; and "Housing: The Need for Incentive," by Alan E. Munby.

The Editorial, Advertisement and Publishing Offices of "THE ELECTRICIAN" *are at 8, Bouverie Street, London, E.C.4. Telegrams: Benbrotric, Fleet, London. Telephone: City 9853 (4 lines).*

The subscription to "THE ELECTRICIAN" *is* £2. 12. 0. *per annum in the United Kingdom, and* £2. 14. 0. *per annum Abroad. Advertisement Rates can be obtained on application to the Manager. Advertisement copy and blocks should be received on the Friday preceding date of publication*

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,192. [Vol. LXXXIV. No. 21.] FRIDAY, MAY 21, 1920. PRICE ONE SHILLING. By Post, 1s. 1d. Abroad 1s. 2d.

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Notes.

Progress of the British Electric Vehicle.

It is gratifying to note that there is an early prospect of the Electric Vehicle Committee crystallising into the Electric Vehicle Association of Great Britain. The presentation to Mr. FRANK AYTON by the electric battery vehicle makers on Monday evening last marks the opening of a new era in battery traction in this country. As is well known, Mr. AYTON has rendered signal services to the battery vehicle movement, and the Electric Vehicle Committee owes its existence in great measure to his efforts. A fitting tribute has been paid to his work in the presentation referred to and to the fact that he is the first chairman and honorary secretary of the new association. Probably no section of the electrical industry has suffered so much through lack of co-operative effort as the battery vehicle business. Not so many years back the battery makers themselves would not even gather round the same table. Happily this is to be altered in the new association, which will co-ordinate the battery makers, the makers of motors and controllers and the builders of the chassis. The result is there should be an early boom in vehicles of this class, not only for commercial, but also for pleasure, purposes.

Electricity Supply at Blackburn.

To compare the designs of the new generating station at Blackburn, the foundation stone of which was laid last week, with the lay-out of the existing station is to be struck by the changes which have occurred in our outlook within recent years. The old station, from the modern point of view, is about as unsuitable as it well could be. It is in the centre of the town, so that all coal has to be carted through the streets, no river or canal is available for circulating water, and the site permits of no extensions. The Electricity Committee has therefore done that obvious thing, which it is sometimes so hard to do, in deciding to obtain a fresh site, and Mr. WHEELWRIGHT is to be congratulated on the use he has made of the means at his disposal. It will be possible to bring coal to the site either by rail or road, a sufficiency of circulating water is obtainable, and there is plenty of room for extensions. Naturally large turbine units will be employed, a start being made with two of 10 000 kw. Although peat is to be found on the site, apparently the temptation to use it under the boilers has been resisted, a decision which will probably trouble some people, but is, nevertheless, the right one. The demands for electrical energy in Blackburn are increasing rapidly, and the new plant will be wanted as soon as it can be set to work, if not before

The New Act in the North-West Midlands.

WE are informed that a linking-up scheme has been prepared for the consideration of the Electricity Commissioners by the electricity undertakings operating in what may conveniently be called the North-West Midlands. The area involved covers the whole of Staffordshire, except the extreme easterly portion, with parts of Shropshire and Cheshire. It includes the industrial district round Wolverhampton and Birmingham, though not the latter city, and the Potteries, so that there is plenty of outlet for development. The scheme is due to a committee of the electrical engineers of the undertakings in the area, working under the chairmanship of Mr. S. T. ALLEN in conjunction with Mr. J. H. RIDER. Besides carrying out the linking-up of existing networks, it is proposed to erect a station with a capacity of about 20,000 kw. at Stoke-on-Trent to deal with immediate needs, and also to proceed with the first part of a new capital station at Rugeley sufficient to contain 30,000 kw. The latter site, though probably the best that could be chosen, is not ideal, for, though near the coal fields, water is scanty, and to develop its full capacity of 60,000 kw. it will be necessary to erect cooling towers. It is proposed eventually to build a second capital station at Iron Bridge on the Severn, where it is thought a plant capacity of 125,000 kw. can be installed if a dam is erected in the river. Its only disadvantage is that it is some distance from the centre of gravity of the area. It is estimated that the total requirements vary between 200,000 kw. and 250,000 kw., the total plant in the existing stations being about 100,000 kw. As is well known, this area contains stations supplying at a variety of voltages and frequencies, and it is hoped to discontinue the use of these and concentrate on three-phase 50-cycle generation. The scheme bears the marks of careful thought, and we are glad to see that all the undertakings in the area, with the exception of Walsall, have been concerned in its preparation. We have no doubt it will be accepted by the Commissioners, and we hope that the work will then quickly go forward.

The Labour Outlook.

To those who can read the signs aright, it is evident that an improvement in conditions in the labour world may shortly be expected, together with a lessening of the turbulence which is now so prevalent, and a gradual settling down to work. If this change comes about it will benefit everyone, and not the least the worker himself. This conviction that things are about to improve may seem unduly optimistic when the constant disturbances which are still upsetting the industry of the country are called to mind ; but these disturbances are, more than ever they were, fomented and carried out by a small band of strident extremists, whose actions are causing more alarm among trade unionists themselves than among the general public. A lunatic is amusing so long at he throws bricks at other people, but when he starts to throw bricks at you it is another matter. This is just what is happening now. Until a short time ago the moderate men found their more fiery companions useful. They admittedly employed methods which the more level headed would have scorned to use ; but they obtained results without much damage to the organisation. That is no longer true. The public is beginning to realise that a halt must be called to these constant demands for increased wages. The trades unions leaders are beginning to see that higher wages will not bring lower prices. The men are finding that higher wages are not much good when they will buy no more food and tobacco. The moderate man is asking himself why the golden promises of the extremist are turning out to be dross. It is a state of affairs which will lead to a recovery of sanity before long.

The Railway Men and the Public.

WE reiterate that this is the tendency ; and it is a tendency whose rate will rather be accelerated than retarded by the latest applications by railwaymen's unions for large increases in wages. These unions are claiming a flat rate increase of £1 a week, and it is stated that an advance of 10s. per week will probably be conceded, at a cost of £15,000,000 a year to the nation. This claim is not based on any such superficially logical foundation as an increase in the cost of living ; but is simply made because, wages in other trades having been increased, the margin between them and the money received by the railwaymen has become narrower. Such an argument removes any discussion on the rates of pay from the realms of economic science or from the ethics of remuneration for work done to the sphere of a round game. This in itself is likely to bring a speedy check to this policy. Apart from the fact that such increases will mean a further increase in fares and a further rise in the cost of living, we may, also, in justice ask where the money to pay these charges is to come from, when every concession seems to be followed by a decrease in the work done ? The railwaymen are rapidly losing public sympathy, and it is a little difficult to see what they will gain by that or by forcing the country into bankruptcy. We are glad to see that the enquiry is being held in public. This will expose to general view how flimsy, and even ridiculous, are some of the pretexts for increased wages. When a travelling ticket collector advances as a reason for such rise the fact that he has sometimes to stop people playing cards, we are led to think that the day of the extremist must be drawing to a close.

Progress in Illuminating Engineering.

THE annual report of the council of the Illuminating Engineering Society, which was presented at the meeting last week, revealed good progress. The Society has evidently completely restored its regular routine of work, which was diverted into special channels during the war. The Papers during the past session have covered much useful ground, and several of the discussions, notably that dealing with lighting conditions in mines, seem likely to lead to further useful investigations through the medium of joint committees. We understand that the work of the Committee on Eye Strain in Cinemas is in an advanced stage, and it is hoped that their report may, after presentation to the London County Council, be made public. A feature of all this work is the leaning which the Society has shown for co-operation with other bodies. Thus, in the discussions and investigations mentioned above, the Council of British Ophthalmologists and other bodies concerned with vision have taken a prominent part. The Illuminating Engineering Society was early in the field in initiating this form of joint effort which has greatly added to its prestige, and there are some technical societies which might well take a hint from their methods in this respect. Similarly, in the international field of action, the Society seems to be exceptionally alert, and is taking the opportunity, through the person of its hon. secretary, Mr. GASTER, to bring the question of industrial lighting prominently before the forthcoming congress of the Royal Institute of Public Health in Brussels.

Symbols.

MOST electrical engineers will agree with Major EDGCUMBE that the symbols employed by Mr. SYDNEY EVERSHED in his recent Institution Paper are likely to cause confusion. The use of letters to represent certain electrical quantities is, after all, only a species of shorthand, and if that shorthand is to justify its existence it must instantly and unconsciously recall to the reader the quantity for which it stands. It follows that when convention decides that a particular quantity should be represented by a particular letter, to use that letter to represent some other quantity or to represent that quantity by some other letter is equally undesirable. This dictum is quite general in its application. The new phonetic spelling, of which we used to hear so much, soon fell into desuetude, even in the land of its birth, not because it was less right than older methods but because it offended against convention. And so with symbols. If then a writer on engineering subjects uses, as Mr. EVERSHED does, V to represent motive force instead of voltage, he is taking the great risk of alienating his readers, and the complexity of the subject dealt with only increases the risk. His excuse that he has always used that particular symbol in that way is begging the question. The Paper was admittedly written to stimulate thought, but to do that the subject matter must be presented in the simplest possible manner or it will act rather as an anodyne than a stimulant. We therefore hope that Mr. EVERSHED will see his way to adopt the suggestion to revise the symbolism he has employed for so long before the Paper is published in the journal. This is the more necessary, for as Col. CROMPTON justly remarked, the subject matter is of world-wide interest.

Government Finance.

THE obscurity which surrounds the methods which the Government propose to employ in liquidating our war debt is not likely to be dispersed by the report of the Select Committee which has been considering the question of a levy on the so-called war wealth. The Committee's principal achievement is that it has produced a report at all, though it has not found it possible to go just that one step further and recommend its adoption. Another surprising thing is that, though Mr. A. J. HOBSON, president of the British Association of Chambers of Commerce, was specially asked to put forward his views, the report was prepared before his reply had been received. This rather looks as if some special pressure had been brought to bear by interested parties, and gives rise to a feeling of uncertainty as to what is really intended. The prospect is indeed one which must cause the greatest anxiety to the stoutest financial heart. It is true the Capital Levy is supposed to be an alternative to other methods of getting money; but, then, so were the Corporation Tax and the Excess Profits Duty. What guarantee is there that all three will not be brought into operation together? The only thing certain is the uncertainty as to when this bleeding process is going to cease, for, heavy though they are, both these taxes are in addition to the Income Tax, which by itself may amount to as much as 8s. in the pound.

Bleeding the Industry.

Of the two alternatives, if alternatives they be, the Excess Profits Duty with all its disadvantages is to be preferred. The Federation of British Industries is opposing by all means in its power any suggestion of a Capital Levy, and is using its best endeavours to secure at the Committee stage of the Finance Bill such amendments in the Excess Profits Duty clauses as will remove the worst anomalies. These include a revision of the standard of profit, equality of treatment, stock valuation, recovery of deficiencies and subscriptions to trade associations. The Corporation Tax is also receiving attention, especially the suggestion that it should replace the Excess Profits Duty. This attitude of inquiry we feel sure will be supported by commercial interests throughout the country. For a levy on war wealth can only be a levy on capital in general and will not only check all enterprise, but will press particularly hardly on those who during the last five years have in accordance with the advice of the Government, saved every penny they could. On the electrical industry it will press particularly harshly at a time when fresh capital would enable the disturbances caused by the war to be removed, and a stiff front presented to our many competitors both in the home and foreign trades. The cry is all for increased production, but that cannot be obtained without more capital, any attempt to divert which from its legitimate channels can only result in disaster. The liquidation of war debt is an operation about which there must be no undue haste, and though we agree money must be raised, it must be raised in a way which will prevent permanent harm being done to the industry. Above all we must have some assurance that it will be properly spent.

Wireless Telephony in Newspaper Work.

While it may be argued that the Daily Press of this country are lacking in knowledge, balance and a love of the truth for its own sake, it will be agreed that they are enterprising. Nothing is too much trouble and no expense is too great when it comes to the development of a "stunt," or when for any reason it is desirable to employ some new and strange means to outdistance a contemporary, be it by even so little. The latest example of this policy, which is not without its commendable side, is the installation by the "Daily Mail" of wireless telephone apparatus, whereby messages from the world's wireless stations can be received. The technical features of the apparatus follow closely the details of that described on another page of this issue; but the real interest lies in the step forward this marks in the collection of news by the cutting out of a number of intermediate links, from the telegraph instrument to the messenger boy, which have been necessary when the older methods were employed. At the moment it is a little difficult to see exactly along what lines wireless telephony will develop. That it will not for a time, if it ever does, take the place of ordinary telephony for short distance work is pretty evident; but for purposes similar to that to which our contemporary is putting it, for communication between ship and land and ship and ship, and for aeroplane work, it can be immediately and usefully employed.

The Admiralty and Scientific Research.

The Admiralty is to be congratulated on appointing Dr. F. E. Smith, F.R.S., director of scientific research, and on obtaining £302,000, though this is £110,000 less than last year, for carrying on the work with headquarters at the National Physical Laboratory. This is spending money in the right way, and it is not, therefore, surprising that certain members of Parliament took exception to it. Those who listened to Dr. C. V. Drysdale's Kelvin lecture, recently delivered before the Institution of Electrical Engineers, will have gained some conception of what has recently been done in obtaining entirely fresh knowledge in one branch of marine work. There are others in which our ignorance is still profound, and where, therefore, it would be of the greatest advantage for fully-equipped scientific investigators to enter. It is well that this work should have some sort of official *cachet*, for it is only in this way that overlapping can be avoided, and all the work turned out directed to a useful end. We wish the new department every success.

Electric Supply Powers.

Many electric supply authorities have found that the provisions of the Electric Lighting Acts are inadequate to meet all circumstances arising from the rapid extension of the various applications of electricity. They have, therefore, been compelled to promote private Bills for supplementary powers—*e.g.*, to enable them to deal with recalcitrant consumers, to provide for stand-by supply cases, to hire electric motors and fittings, to equip and maintain showrooms, &c. In this year's Bill the Corporation of Halifax have secured some useful ancillary powers, and, as other supply authorities may be interested in the question, we append a summary of the more important of the provisions relating to electricity supply. The Corporation have been empowered to fit up showrooms and offices, "exhibit specimens and installations," and give demonstrations of the uses to which electrical energy can be put. The operation of Sec. 15 of the Electric Lighting Act, 1909 (relating to stand-by supply), has been extended to premises having a separate supply of power, whether such separate supply be by electricity, gas, steam or other sources of power.

Hindering Officials.

Persons hindering the Corporation's officers from entering consumer's premises are rendered liable to a penalty not exceeding 40s., and to a daily penalty not exceeding 20s.; and unoccupied premises may, after 48 hours' notice to the owner, be forcibly entered. A consumer's notice of discontinuance of supply must be in writing and signed by him or on his behalf. If a consumer uses electricity contrary to the terms of his agreement, the Corporation may, after seven days' notice in writing, discontinue the supply; and any reasonable expense of re-connecting may be recovered by the Corporation. In addition, the Corporation's area of supply has been extended to the urban districts of Mytholmroyd, Luddenden Foot, Soyland, Midgley, Stainland, Sowerby and Barkisland and parts of the rural district of Halifax; and the period within which these local authorities may exercise their right of purchase under Sec. 2 of the Electric Lighting Act, 1888, is six months after the expiration of 42 years from the passing of the Act.

Unfortunate Secrecy.

At the present time when great efforts are being made to secure that electric lighting should be a feature in all new houses and the extension of the domestic electric load will be one of the problems of the immediate future, it is desirable that attention should be paid to the power for good that may be wielded by the electrical contractor. As often as not the contractor has other than purely electrical interests, and he naturally devotes most attention to that interest which pays him best. It is, therefore, regrettable to find the "Electrical Contractor" declaring that misunderstandings exist between those whom it represents and the Electrical Lamp Manufacturers' Association over selling agreements, discounts and especially over the refusal of the latter to form a Standing Joint Committee of lamp manufacturers and contractors before whom points of difference can be discussed. Upon the rights and wrongs of these matters we have no means of pronouncing as all negotiations are carried on in secret, but it seems a pity that both sides should not do their best to remove the cause of friction, which probably is small.

The Operations of Trade Unions.

The introduction of Joint Industrial Councils has caused a great expansion in the activities of Trade Unions. For not only has the membership of the workers' organisations increased, but in some industries employers have also formed unions for their mutual protection. As a corollary to this development there has recently been abundant litigation challenging the operations of some of these organisations.

Jealousy and Officialdom.

A good deal of this trouble appears to arise from the jealousy of rival Trade Unions, but some of it is also due to the tendency of certain Trades Union officials to arrogate to themselves the right to decide summarily and without hearing both sides, disputes between individual members and their unions. This is regrettable, for it can only militate against the progress of trade organisation by creating popular prejudice against it. It must be remembered that in these cases the officials and executives of Unions have quasi-judicial functions to perform, and care should therefore be taken that the case of the defendant as well as that of the complainant is fully investigated.

Conspiracy and Intimidation.

For instance, in a recent case before Mr. Justice Astbury, a workman named Edwin White, who was a member of the Workers' Union, obtained an injunction (and £75 damages) against two members of the Carriers' Society. The plaintiff was employed by a Walsall company and he alleged that the defendants conspired by threats, intimidation and coercion to procure his employers to terminate his contract of employment on December 5, 1917. One of the defendants was chairman of the "shop" meetings, and claimed to decide whether and under what circumstances employers and workmen should be allowed to earn their daily bread.

In his Lordship's opinion the acts of trade unions and their officials, done in furtherance or support of a claim of that character, the insistence upon which might cause grave injury or ruin to other people, required careful scrutiny, when questioned, in order to ensure that the wide and generous limits of the law as to the powers of trade unions were not exceeded or abused.

Punishment by Coercion.

It appeared that the defendants tried to induce the plaintiff to cease his membership of the Workers' Union and join the Carriers' Society. His lordship found the defendants guilty of the allegation of conspiracy and of inducing a direct breach by the employers of plaintiff's agreement of service; also that plaintiff had suffered damage by reason of defendants' tortious and wrongful acts. He said the real reason for defendants' act was to punish the plaintiff for not subscribing to the Carriers' Society, and that it was not a dispute within the meaning of the Trades Disputes Act, 1906, on which defendants relied.

Suspension as Punishment.

In another case, which was recently decided by Mr. Justice Lawrence, a member of the National Amalgamated Labourers' Union alleged that he had been wrongly suspended from the position of Treasurer and trustee of a branch of the Union at Cardiff. In the course of his judgment, the learned judge said that the power conferred upon the Executive Committee to remove officers, &c., was of a quasi-judicial character, and that in common fairness a man charged with a breach of the rules of a union of which he was a member ought to be heard before being condemned. The executive committee acted in good faith, but they were entirely wrong in not hearing him fully before they came to a conclusion in the matter. Therefore, he held that the resolution passed by the executive was not warranted by the Rules of the Union and could not be relied on by the defendants, against whom an injunction was granted with costs. In our opinion it would be desirable to refer disputes such as these to the National Joint Industrial Council of the industry affected or to Industrial Arbitration Courts rather than spend time and money in expensive litigation.

Pressure by an Employers' Association.

In a third case, which recently came before the Court of Appeal, the question was raised whether an association of employers could be made liable legally for bringing pressure upon one of their members to discharge an employee who had formerly been in the employment of another member of the association. The defendants were four officials of the West and Mid-Wales Yeast Dealers' Association, which was in the nature of a trade union. It consisted of employers engaged in the supply of yeast, and its members included all the principal employers in that trade. From August, 1917, until February 15, 1919, the plaintiff was employed by the Secretary of the Association as branch manager of his business at Neath, and he left his employment early in February, 1919.

Later in the month the plaintiff entered into the employment of another member of the Association, as traveller in Neath. It was alleged that plaintiff began to canvass his old customers on behalf of his new employer, and that in consequence of the pressure by the Association the plaintiff's new employment was terminated.

Unreasonable Restraint but not Coercion.

Mr. Justice P. O. Lawrence held that Rule 20 (which provided that the secretary should report to the members the names of employees leaving the service of an employer) of the defendants' rules was void, as being an unreasonable restraint of the trade, but that that did not make the acting under it an offence at common law. A person who procured another to do an act which was not wrongful so far as that other was concerned could only be made legally responsible if he procured his object by illegal means, but in his Lordship's opinion no such illegal means had been used, and the plaintiff had failed to prove that any coercion had been practised by the defendants. The plaintiff appealed but the Court dismissed the appeal.

In the course of his judgment the Master of the Rolls said that the plaintiff was doing what it was his legal right to do; there was no restrictive covenant binding upon him and therefore he was legally justified in taking away customers from his old to his new employer. He would exprees no opinion whether it was a fair thing to do, but it was conduct which his old employer would naturally resent, and if it became the regular practice, objection would be taken to it by traders and traders' asociations generally. His new employer refused to give the plaintiff notice to leave his employment and thereupon a meeting of the Association was convened to enforce Rule 20. The learned Judge accepted the evidence of the secretary as to what happened at that meeting, and found upon that evidence that there was no threat or coercion employed against the offending employer. That evidence having been accepted he could not see his way to differ from the finding of the learned Judge.

After referring to the decided cases his Lordship said the new employer was entirely within his legal rights in giving the plaintiff notice to leave his employment. There was no attempt to induce the new employer to give notice to the plaintiff to leave his employment in any event. What was suggested was that he should no longer continue to employ the plaintiff for canvassing the previous employer's customers. He found there was only persuasion and that no illegal means were used to carry out what was a rightful act in itself. The appeal was therefore dismissed.

All these cases point to one thing. That Trades Unions and Employers' Associations have their responsibilities as well as their privileges. In many ways they are exempt from the ordinary operations of the law, but that is only the more reason why they should for their own sake direct their policy in accordance with the ordinary rules of equity.

Electric Traction Problems.

Until the Committee, recently appointed by the Ministry of Transport, has made its report it is unlikely that electric traction on the railways of this country will emerge from the stagnation into which it has fallen. This is one of the minor disadvantages which follow State Control or rather which are an inevitable corollary to that lack of individual responsibility which is so evident in Government Departments. It is easier to appoint a Committee to consider a question than for a Minister or official to make a decision; and there is the added advantage that the Committee will subsequently be a convenient dumping ground for any criticism.

The Financial Side.

It must be admitted, however, that without the Ministry's assistance the companies would find it very difficult to raise money for electrification schemes at the present time; and it is right that those who are providing the money, in this case the nation, should have some say as to its expenditure. Nevertheless, we hope that the Committee, while giving the full benefit of their advice on the technical problems which they have been appointed to consider, will resist any temptation to make the railway companies adopt schemes which their own engineers consider unsuitable. There are two reasons for this. A man who has to carry out a job he does not like never does it well, and the traffic, and therefore the whole conditions of working, differs very widely on, say, the North-Eastern and the London, Brighton & South Coast Railways.

The G.E.R. Scheme.

This attitude of aloofness is all the more necessary because several of the railway companies have already prepared schemes for electrifying parts of their systems. The Great Eastern Railway is one. The enormous suburban traffic handled by this company is well-known, and considering the advantages of electric traction for dealing with this class of traffic the only wonder is it has not been adopted before. In a recent address to the Institute of Transport, Sir H. W. Thornton, general manager of the company, said that they hoped to increase the existing train service by 40 per cent. This can only be done, we imagine, by electrification, and though he did not say so, definitely, he admitted as much by implication. The Midland and the South-Eastern & Chatham Railways have also schemes under consideration.

The Extension of Electric Lines.

That electrification brings advantages in its train is obvious from the fact that a number of railways which have already adopted electric traction on sections of their system are proposing to extend its use. The Great Western Railway is already carrying out the electrification of the Ealing and Shepherd's Bush section. The Lancashire & Yorkshire Railway is contemplating the electrification of the line from Manchester and Oldham and on to Shaw and Royton. The London, Brighton & South Coast Railway wishes to complete the scheme designed before the war for the electrification of the whole of their suburban lines. The London & North-Western Railway are again working on the section between Chalk Farm and Queen's Park, which was stopped by the war. The London & South-Western Railway, which is an outstanding example of the success of electrification, is considering the question of extending electric working over the Cobham and Leatherhead lines as far as Guildford, while, as is well known, the North-Eastern Railway propose to electrify their main line between York and Newcastle-on-Tyne.

The Handling of Goods Traffic.

The outlook for electric traction is therefore bright. Finance is the chief obstacle, though labour troubles and difficulties regarding delivery also take their place among the anxieties of railway officials. But these difficulties must be only temporary; and it is essential that they should be overcome. As Mr. Roger T. Smith pointed out in his presidential address to the Institution of Electrical Engineers, to handle the goods traffic of this country electrically will generally result in a substantial saving, and it is for every reason work that should be taken in hand at once.

Suburban Traffic Problems.

As regards suburban passenger traffic finance is a secondary consideration, because expenditure on improving the means of transport is essential. Most of our railways are now carrying the largest number of passengers at rush hours that their systems can support with, it may be added, a maximum of discomfort to those passengers. This traffic will increase as more houses are built on the outskirts of our large towns and Garden Cities are developed. Electric traction or a complete reconstruction of our railways are, therefore, alternative solutions, one or other of which must be adopted without delay.

We hope, therefore, that the report of the technical Committee will be shortly available and that the Ministry of Transport will lose no time in carrying out its recommendations. The traffic problems to which electrification gives rise must also be considered and solved, as these are just as important as those of a more technical character.

Core and Incremental Losses in Rotating Machinery.

By LAURENCE H. A. CARR, M.Sc. Tech., M.I.E.E.

Owing to the varying proportions of different parts of the magnetic circuit, different shape of pole shoes, &c., used by different designers, it appears to be impossible to lay down a simple law which will cover the core losses of all machines. The consideration of core loss curves of some 300 or 400 different machines, however, has led the author to conclude that it is possible to lay down a general type of equation and to state the approximate values of the numerical constants for different cases, together with the effect of the various disturbing factors on the magnitude of the losses. It is convenient to divide the subject into two parts: (1) The core and so-called "stray" losses observable at no load; (2) the alteration in these losses with load.

No Load Core and Stray Losses.

The loss at no load consists of:—

(*a*) The loss in the core body and teeth due to the fundamental periodicity.

(*b*) The loss due to "tooth pulsation" and loss dependant on the tooth periodicity.

(*c*) The increased loss due to saturation.

(*d*) The eddy current loss in the conductors.

At low saturation losses (*c*) and (*d*) do not appear, so that low saturation tests may be used to determine (*a*) and (*b*).

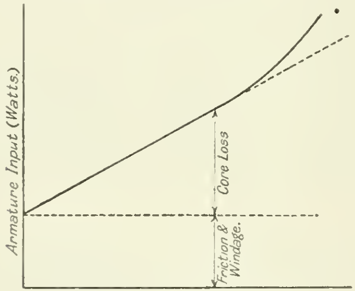

Fig. 1.—Typical Constant Speed Core Loss Curve.

In past years it has been suggested that the no load core losses consisted of the sum of the hysteresis and eddy-current losses, the hysteresis loss varying as frequency and $B^{1\cdot6}$, the eddy-current loss varying as (frequency)^2 and B^2.

In practice, however, with rotating machinery—both direct and alternating current—it is the author's experience with a large number of machines of many different makes that the no load core loss at constant periodicity varies exactly as B^2, except at high saturations on salient pole machines. A typical curve is shown in Fig. 1, and it is to be noted that the upward bend starts at about the same place as the knee of the magnetisation curve.

An induction motor (corrected for stator copper loss) gives a curve similar as regards the lower part, but straight throughout, without the bend. Further, the variation with periodicity at constant flux of the no load core losses should, if the hysteresis plus eddy-current theory be correct, contain one portion proportional to the speed, and another portion proportional to (speed)^2. If, therefore, watts per revolutions per minute be plotted against speed, the no load core loss should give a straight line—the Kapp line, as it is sometimes termed. As a matter of fact and experiment, this line is not straight, but is always curved, again proving that the core losses cannot be calculated from the simple addition of eddy current and hysteresis.

By plotting the no load core losses on logarithmic square paper an empirical formula for the variation with periodicity can be obtained, and it is found by experiment that the core loss over a range of periodicity of from about 10 to 80 periods per second follows very exactly a law of the type f^n, that is to say, the no load core loss is directly proportional to some power of the frequency. This power is, however, not always the same. There is a well marked difference between alternating and direct-current machines, and also a difference between different makes. The value of "n" for direct-current machines appears to vary from 1·5 to 1·7, but is practically constant for a given line of machines. The value for alternating-current machines is about 1·2 to 1·25.

If the sum of (flux density^2 × volume of iron) be taken over the whole armature or stator considered, the losses measured in various experiments can be reduced to a common basis. Easier to think about than a mere constant, however, is a definite value—*e.g.*, the watts per cubic inch of iron for $B=100{,}000$ per square inch at 50 cycles, which is taken as a criterion, and which is termed the "core loss factor" in this Paper. In evaluating this figure the tooth density is taken to be its apparent value. For direct-current machines the core loss factor varies from about 4·8 to 6·0 and for induction motors and alternators from 2·2 to 2·7, and occasionally even up to 3·5. Individual machines, of course, occasionally occur outside those limits. Comparing these figures with the iron tested as a transformer core, the figure for lohys, the material used for practically all the machines considered, is only 1·08. The following figures may be tabulated to show the comparison more clearly:—

Watts lost at $B=100{,}000$. $f=50$ per cubic inch of iron.

——	Loss.	Varies as
Lohys	1·08	B^2
Alternating-current machines ...	2·2 to 2·75	B^2, $f^{1\cdot2}$ to $f^{1\cdot25}$
Direct-current machines	4·8 to 6·0	B^2, $f^{1\cdot5}$ to $f^{1\cdot7}$

That the increased loss in built-up machines is not due to the working the plates receive has been proved by using notched plates as a core and winding it with turns, in the manner of a ring transformer. The average of tests on two such cores gives a core loss factor of 1·10, and a variation with the 1·3rd power of the frequency, agreeing closely with the makers' figures for lohys. The difference between the figures obtained on the finished machines and the raw material is, in the author's opinion, *entirely* due to the slots. In the case of direct-current machines, where the ratio of slot opening to air-gap is large, the flux under the pole face has to swing to and fro as the slots pass; consequently, this loss occurs chiefly in the pole face. In the case of induction motors, due to the pulsation of flux as the teeth pass each other, the extra losses may be in either stator or rotor teeth, or both.

The evidence which supports the author in this belief may be tabulated as follows:—

(*a*) Direct-current machines having a larger slot opening than induction motors have a much higher core loss factor.

(*b*) Comparison of two lines of machines by different makers shows that, on the average, the line of machines with the smaller ratio slot opening/slot pitch has a core loss some 15 to 20 per cent. less than the other line.

(*c*) Comparison of different sets of alternating-current motors give core loss factors of 2·2, 2·7, and 3·5 for three types of induction motors, practically identical as regards design constants, except that the first set had small slot openings in both stator and rotor, the second set had relatively large slots opening in the stator, but small ones in the rotor, and the third set had large slot openings in both stator and rotor.

(*d*) Induction motors with open slot stators give exceptionally large core loss factors, figures as high as 5·4 and 5·7 being reached.

(*e*) Standstill tests on three induction motors selected haphazard gave the core loss factors at rest of 1·14, 1·32 and 1·20, closely agreeing with the figure for lohys above. At full speed these three machines gave figures of 1·87, 2·14 and 2·03 respectively, being thus a little better than the average of 2·2 quoted above.

It therefore seems abundantly clear that all the losses above those corresponding to the factor 1·08 (the legitimate core losses, as they are sometimes called) are in the teeth or pole face. This has a most important bearing on the cooling of machines, as the heat is thus nearly all produced in the hot belt round the air-gap, the loss in the core body itself being relatively small, and much smaller than would exist in that place if the total core loss were uniformly distributed in proportion to the square of the flux density. Eddy-current losses are generally assumed to vary as the square of the frequency This is, however, only true as long as self-induction is absent, the loss increasing less fast than the square when the reactance is not negligible. The higher the ratio of reactance to resistance the lower the power of the frequency with which the watts lost appear to vary, and this is probably the explanation of the index of the frequency found by test.

In actual practice it appears that there are two losses present, the "legitimate" iron loss varying as the square of the fundamental frequency, with perhaps a small hysteresis part varying directly as that frequency, and the tooth pulsation loss at a very much higher frequency varying approximately as some power of this frequency, less than the square, but otherwise unknown. The core loss factor for the "legitimate" loss is 1·08 as given by the makers, or 1·20 as determined by experiment on induction motors at standstill. This latter figure is to be preferred, since it automatically corrects for any error in the method of calculating the tooth density. At first sight it would appear possible to subtract this portion from the experimentally determined core loss, and obtain an empirical formula for the tooth pulsation loss. In practice, however, this method is almost impossible to deal with satisfactorily, owing to the large number of variable ratios, such as slot opening tooth pitch; slot opening air-gap; tooth frequency/fundamental frequency, &c., and considerably more work is required before this method of treatment can be expected to yield practical results. Under these circumstances, it appears to be rational to use the best empirically determined law to determine the whole loss. In one case alone has any attempt been made by the author to separate the tooth pulsation losses and to give a formula expressing it. This has been done in the case of induction motors with open stator slots.

Desirable as these are from an insulation point of view, the fact must be faced that their use is accompanied by a large increase in core loss. Careful design can be used to reduce this loss to a minimum, but even then it is large. The stator and rotor slots should be as nearly as possible equal in number, as it is obviously unwise to allow a rotor tooth to be small enough to lose all its flux when opposite a stator slot. To close the rotor slot altogether is no advantage (as test results show), as the bridge of iron becomes at once saturated with leakage flux, so that no main flux can be carried by it, and it becomes just as bad as, or worse than, a slot with small opening.

The following empirical rule is probably not exact, but will give an approximate idea of what may be expected with open stator slots. After calculating the legitimate core loss, using a factor of 1·20 for both core body and teeth, the extra loss in watts equals

$$1{\cdot}15\left(\frac{f}{1{,}000}\right)^{1{\cdot}5}\pi dla$$

for an average air-gap flux-density of 25,000 per square inch, where

d = rotor diameter in inches.
l = net core length in inches.
a = sum of rotor and stator slot depths in inches.
f = average periodicity of pulsation—that is, the mean of the number of stator and rotor slots multiplied by the revolutions per second.

Alternators with semi-closed slots appear to have much the same core loss as induction motors. Alternators with open slots (and small air-gaps) appear to have a loss some 50 per cent. higher than those with semi-enclosed slots. Though results are not numerous on this class of machine, it is quite clear that the losses are lower than with direct-current machines, the explanation probably being that the number of slots is usually high, to keep up the number of slots per pole and phase, with a correspondingly smaller ratio of slot opening air-gap, and hence less pole-face loss.

Another most important factor is the pressure between the laminations composing the core. In the author's opinion, this is far more important than the amount of filing the plates receive, and is the cause of the variation between the core losses of identical machines. The insulation between the laminations may also have a serious effect on the losses, if the laminations are not separated into packets either by ventilating ducts or other methods. Four totally-enclosed induction motors were recently built with core lengths of from 10–14 in., with plates insulated with varnish, but without ventilating ducts, or any special precautions, such as occasional paper insulation. The core loss factors of these machines came out high in every case, averaging 3·16, as against 2·2 with motors of the same size exactly similar, except for ventilating ducts dividing the laminations into packets 3 in. or 4 in. long.

With salient pole machines, *i.e.*, direct-current machines and slow-speed alternators, increased core loss (above the square law) is apparent at high flux-densities, that is, when saturation has set in. This loss is greater with strip or bar-wound armatures than with armatures wound with stranded wire or round d.c.c. wire. This increase begins to appear at a tooth density of about 100,000, and for an apparent density of 150,000, the increase (above the loss proportional to B^2) is about 20 per cent for wire wound and 50 to 60 per cent. for strip-wound armatures or stators. The difference between these two is clearly eddy current loss in the armature conductors; but the cause of the increase with well subdivided armature conductors is not clear, though the loss certainly exists. It may possibly be due to eddy current losses in the cast iron clamping plates and winding supports of the armature. Being a difference between two curves, the exact value of this factor is difficult to determine accurately; but the curves given in Fig. 2 may be taken as an approximation to the magnitude of this loss.

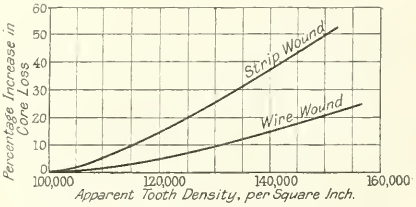

Fig. 2.—Increase of Core Loss in D.C. Armatures due to Saturation.

Incremental Loss, or the Increase of Loss on Load.

The incremental loss is not due to the appearance of a new loss with load, but its existence is due to the fact that the losses previously considered increase when load is applied. When a machine is loaded, ampere-turns are produced in the armature (if a direct-current machine or alternator), or in the secondary (if an induction motor). In order to keep the total flux constant, the exciting ampere-turns have to be increased; but in every case the result is a displacement of the ampere-turn wave in space, and hence of the flux wave. In induction motors, with approximately sinusoidal disposition of the ampere-turns, and with reluctance unchanging despite the shift of the flux, the core loss remains the same; there is merely a change of position over a symmetrical surface. Consequently there is no incremental loss, either by theory or experiment. With a salient pole machine, however, besides displacement, there is *distortion*. Due to the large reluctance of the interpolar spaces, the flux has to hang on the edge of the pole, and, instead of the flux-space wave being approximately flat-topped, it is now very much peaked on one side. If a tooth be imagined as a unit, this passing through the field will have a voltage generated in it proportional to the flux density B. The eddy-current loss in it will be then proportional to B^2 at any moment. The total loss per cycle will be proportional to $\Sigma B^2 d\theta$ from $\theta = 0$ to $\theta = 2\pi$, where θ is the angle round the armature. Similarly for the other teeth, so that the whole tooth pulsation loss will be proportional to $\Sigma B^2 d\theta$. The same holds equally true for no load.

In order, therefore, to calculate the incremental loss, firstly the no load loss must be separated into two parts, the legitimate iron loss corresponding to the core loss figure of 1·20 at 50 cycles, and the remainder the no load tooth pulsation loss. In order to determine the full load tooth pulsation loss, the flux distribution curve round the armature must be calculated both for no load and for the load under consideration, and the ratio of the two values of $\Sigma B^2 d\theta$ found, thus enabling the full load tooth pulsation loss to be determined. A correction to the elements of $B^2 d\theta$ to allow for the increased loss with saturation should be added where necessary.

Incidentally, these curves may also be used to determine the "armature reaction," or the number of ampere-turns necessary to be added to the field, to keep the same total flux. This is a laborious proceeding, and consequently it is desirable to find an empirical formula to fit the result obtained by this method. Pursuing this method for a number of similar direct-current machines, it is found that the ratio of *total* full load core loss to *total* no load core loss can be fairly well expressed, over a wide range, from no saturation to as much as is likely to be reached in practice by the empirical formula

$$1 + 0{\cdot}25\left(\frac{\text{armature ampere-turns}}{\text{field ampere-turns}}\right)^2,$$

the value unity thus representing the no load core loss and the remainder of the expression the incremental loss.

It is to be recommended that this formula should be got out afresh for any given line of machines, as it is probable that the constant 0·25 will vary slightly with different designs. Once having obtained this formula, however, it is an exceedingly simple matter to multiply the core loss corresponding to full load flux by $0{\cdot}25\left(\frac{\text{armature ampere-turns}}{\text{field ampere-turns}}\right)^2$, to obtain the incremental loss, which is a matter of great importance in connection with variable speed motors, boosters or other machines where a strong armature and weak field may occur together. Experimental determinations of the incremental loss are difficult to make with accuracy, since only a small difference between output and input is to be measured; but the above empirical formula gives a value which is certainly of the right order.

Slow-speed alternators may be treated similarly; but with lagging power factor the displacement of the resultant ampere-turn wave, and consequent distortion of the flux wave, are greater than with unity power factor, which corresponds to the direct-current case.

In the case of turbo-alternators, however, a further loss occurs. It is usual practice not to slot the pole, but the rotor windings are, of course, embedded in slots. The flux wave is then partially displaced bodily and partially distorted, though it does not hang to the pole quite as much as with a salient pole. But the displaced part is then over the rotor slots, which will therefore have a tooth pulsation effect with the stator teeth, exactly the same as considered earlier in connection with open slot induction motors. The rotor slots are usually wide compared to the stator teeth, and each stator tooth will lose quite a large portion of its flux as it passes a rotor slot, the periodicity of this pulsation being very high, with consequent large losses. Closing the rotor slots with iron or steel wedges will not help at all, since they will at once saturate with leakage flux, and be magnetically impervious to the flux crossing the air-gap. Alternatively, if wedges part steel, part brass be made, so as to prevent this saturation, then the wedges will be subject to flux pulsation as they pass under the stator teeth, and, being solid, heavy losses will be produced in them. This is doubtless the explanation of the heavy "stray" losses mentioned by Dr. Barclay and Dr. Smith in their Paper, "The Determination of the Efficiency of the Turbo Alternator." (I.E.E. "Journal," Vol. LVII., p. 293.)

It is clear from the above that heavy incremental losses may always be expected when there is much distortion—*i.e.*, with a strong armature and weak field—and that an alternator or shunt-wound direct-current generator with good inherent regulation will have less incremental loss than a machine with poor regulation. This rise in incremental losses is so marked that, though the no load core loss of a direct current motor varies with B^2, and may vary with as low a power of the speed as the 1·5th, yet on full load, as a variable speed motor, the full load core plus incremental loss may, after falling slightly, commence to rise, and reach values well in excess of the low speed core plus increment. This is shown in Fig. 3, where the no load loss is taken to vary as the 1·5th power of the speed; the ratio armature ampere-turns/field ampere-turns being one-half at bottom speed, and an average magnetisation curve is assumed.

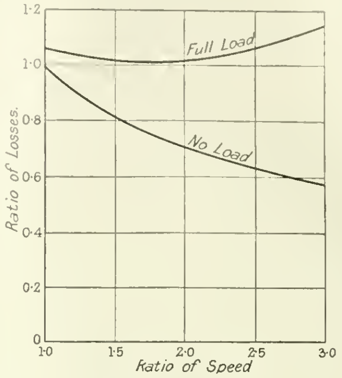

Fig. 3.—Core plus Increment Losses of Variable Speed D.C. Motor.

Stalloy.

A Paper on this subject would not be complete without a reference to the use of such materials as stalloy. The core loss factor for the raw material as given by the makers is about 0·53—about half that of lohys—and the index of the frequency is 1·15, the ratio to lohys thus being greater than 0·5 at low frequencies and less than 0·5 at higher frequencies. When built up into machines this ratio no longer holds good, the advantage with stalloy is not so great. The explanation appears to be due to tooth pulsation. Any pulsation in flux is opposed by the eddy currents which it produces. If a material is used which has less eddy currents, the flux pulsation will naturally increase, and to a certain extent destroy the advantage gained by the use of the higher resistance material.

With standard direct-current and alternating-current machines the ratio of loss with stalloy to loss with lohys appears to be about 80 to 85 per cent.; but with turbo-alternators, where the loss behind the teeth is a larger portion of the whole, this figure is reduced to about 70 per cent.

In conclusion, the author wishes to thank Messrs. The Lancashire Dynamo & Motor Company, Ltd., and J. H. Holmes & Company for permission to publish certain of the figures quoted.

Earthing.—An article in the "Revue Générale de l'Electricité" states that the French rules only deal with the earthing of non-current carrying parts. But the question of earthing windings and live parts is a controversial one, particularly with regard to the earthing of the neutral points of three-phase alternators and transformers. On the other hand instruments and instrument transformers must have their cores and windings earthed, also arresters, &c. The earthing should be done by means of a copper conductor containing as few bends as possible, of section calculated at 1 sq. mm. per 10 amperes of the normal load current of the installation with a minimum of 10 sq. mm.

Automatic Protective Devices for Alternating Current Systems.*

By A. E. McCOLL.

Owing to rapid development in central station capacity, protective gear has now to deal with more severe conditions than heretofore. Protective systems may be classed roughly under the following headings: (1) Leakage protective or core-balance devices either of the current, magnetic, or mechanically balanced types; (2) interlocked discriminating devices such as are applied to parallel feeder protection; (3) differential systems, the operation of which is based on a difference in quantity or direction of the current at each end or side of the protected circuit or apparatus; (4) special cable designs which by their construction partially or wholly function as protective devices; (5) reverse-power devices which operate when the power flows in the opposite direction to that normally intended; (6) simple overload devices which operate by excess current.

Core Balance or Leakage Protective Systems.

Devices of this type are usually dependent for their inactive condition on a summing up of the currents in a circuit. A direct summation may be obtained by connecting the series transformers in star and the protective devices in shunt to the "starred" transformers. A balance may also be obtained magnetically. A third method may employ the currents so as to obtain a balance of forces by mechanical means.

In the original Paper the author then describes a number of such devices. One of these is based on the use of a magnetic balance relay as leakage protective device, in another case a Ferraris disc operates as a mechanically balanced leakage protection device and also as a guard against unsymmetrical loading; a biased leakage protective device is also shown which has similar functions.

A number of systems have the neutral point earthed through a comparatively high resistance, limiting the possible earth current on breakdown of a phase to moderate values. A device intended to protect against unsymmetrical loading, in addition to leakage current, requires a reasonably sensitive setting for earth faults.

Parallel Feeder Protection.

On most power systems a favourite method of feeder lay-out consists in parallel or duplicate feeder supply. Parallel distribution may be either by interconnection between distribution points or by direct radial supply from the generating centre. Protective means for such feeder arrangements commonly take the form of overload relays at the end adjacent to the source of supply and reverse power relays at the remote end; the latter disconnecting a faulty feeder by utilising the reverse flow contributed by the healthy feeders in parallel. Normally, parallel feeders of the same length and cross-section will share substantially in the distribution of the load current. A breakdown on one feeder, however, will alter the relative current values, so that usually the faulty feeder carries the heavier current. Various devices have been developed which take advantage of this condition. They are normally balanced against one another, but immediately operate to select the more heavily loaded of two or more parallel feeders.

The biased principle as applied to parallel feeder protection was first proposed by Mr. Wedmore in the protection of two parallel feeders. The overload discriminating relays employed are of the reactive type, the fixed coils being placed in series with the transformers which are connected for circulating current. The moving coils are connected to equipotential points of the system. Normally, with balanced conditions on the feeders, no current traverses the moving coils of the relays, but the development of a fault will cause the difference current to flow through the moving coils. The relays are, therefore, connected so that when the excess current is contributed by the transformer on No. 1 feeder, the current direction is such that the relay of No. 2 feeder is restrained and that of No. 1 feeder operated.

Directional Relays.

The application of the directional relays to three or more feeders with a parallel arrangement of transformers is shown in Fig. 1. Each transformer circulates its current through one element of its particular relay, the other element which is connected to the balance lead normally carrying no current. If the transformer on the faulty feeder carries the heaviest current the symmetrical loading of the arrangement is disturbed and the excess current splits through the element connected to the balance lead, operating this relay and restraining the others.

The author also discusses the substitution of the mechanically biased relay in such systems, and explains how the principle of mechanically balanced interlocked relays may be applied to parallel feeder groups exceeding two in number. A further scheme of protection for parallel feeders is based on the use of discriminating relays.

The protection at the remote end of the parallel feeders is usually accomplished by means of reverse power relays at this end, any alteration of current direction in the relays being with reference to the potential of the circuit. Various causes have contributed to unsatisfactory operation. Severe fault conditions between phases near the feeder end in most cases result in the potential being extinguished. If the connection for the potential coil is taken from the star potential of the circuit, and the current in the potential and current coils is substantially in phase, we have a shift of 90 deg. in the phase of the potential coil By connecting the reverse relays at the remote end for circulating current, an increase in stability has been obtained. A connection which has recently been employed with success utilises the current, say, in phase 1 and the delta potential across phases 2 and 3.

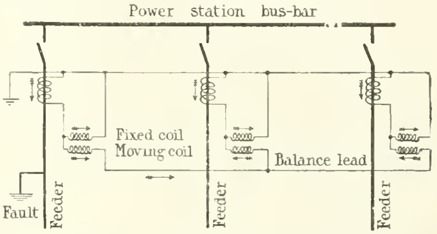

Fig. 1.—Discriminating Relay Protection with Reactive-Type Relays.

Parallel Interconnectors.

The protection of parallel interconnectors by means of discriminating relays is more difficult. Thus with four parallel interconnectors between two power stations, with a fault between phases, a heavier current flows into the faulty feeder at both ends than into the neighbouring ones. If the neutral point of the system is earthed through a limiting resistance this may no longer hold.

The logical development of parallel feeder protection in pairs is found in the "split conductor system." An extension of this principle, but with isolation of the conductors in the form of separate cables, has been extensively employed. The pairing of the cables in this manner often leads to difficulties in balancing, particularly on systems having a considerable plant capacity on the bars.

Unbalancing trouble in evidence in split-conductor cables is often very marked where two cables are paired and protected as one unit. It is questionable if paired feeders are capable of such fine settings as parallel feeders with interlocked relays for a similar degree of stability.

Generator and Transformer Protection.

Protection accorded to generating plant is a comparatively recent innovation. In certain cases such devices took the form of overload relays having delayed action, so that a generator could clear itself from heavy sustained faults on the distribution system, or, by the joint action of a plurality of machines, from a short-circuit within its own windings. An alternative protective means consisted of the reverse power relay, this device operating with a reversal of flow into the faulty generator on a breakdown either between phases or between turns of the same phase.

In the past, protective gear on generating and transforming plant has been looked upon more from the point of view of preserving the continuity of supply than of saving the faulty plant from destruction. However, as power systems have grown in capacity and in the output of individual units the latter point has been more fully considered.

Generating and transforming plant is subject to three classes of fault conditions, viz., leakage to earth on individual phases, short-circuit between phases, and breakdown between turns of the same phase; also accidents to the prime mover and loss of field. The differential system meets the first two conditions satisfactorily, particularly where the neutral is earthed through a limiting resistance. The third condition can only be met by the reverse power relay or some form of split winding. The more satisfactory protection is given by the differential system, which operates equally well with only one unit on the bars. The reverse power relay demands a plurality of generating plant on the bars to give the reversed current or leading current of low power factor required by this device.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

The circulating current system is inherently a sensitive protective means. Full advantage may not be taken of this however, owing to the general unstable tendency of the series transformers under severe emergency conditions.

Protective systems have recently been developed which have for their object a stability under severe emergency conditions and a possible fault-setting not obtainable with the balanced current system.

Stability under Emergency Conditions.

Thus in the system due to Mr. J. R. Beard the input and output of each phase winding is directly compared and any resulting difference due to faults between phases or leakages to earth appears in the secondary of the core-balance transformer. This system may likewise be employed for transformer protection and readily lends itself for this application. To overcome the general unstable tendency of the circulating-current system under abnormal current flow biased relays may also be employed. It is thus possible to guarantee stability, as ample latitude for unbalancing may be allowed. A suitable degree of bias for generator protection with this system would be about 5 per cent., and, with a relay designed to operate at 5 per cent. beyond this, it would be possible to have a 10 per cent. fault-setting with complete stability.

While it is exceedingly difficult with the balanced current system to obtain a dead balance under varying conditions, it is quite easy to secure a definite degree of unbalance. A scheme operating on this principle is shown in Fig. 2, the arrangement being shown on one phase only. The transformers are connected for circulating current and circulate their output through one element, say, the fixed coil of a reactive-type relay, the moving coil being connected in shunt across the system. It is evident that the fixed coil unbalances the circuit in favour of the transformer at the bus-bar end of the winding. Generally it will be found that in most wiring installations for the protective gear the greater lengths lie between the star-point transformers and the relay. This has the effect of unbalancing the circuit still further and increasing the percentage bias of the relay. Unbalance may also be obtained by inserting resistance in that side of the circuit, or by making the current capacity of transformer No. 2 slightly greater than that of transformer No. 1. The effect is to cause a small local current contributed by the No. 2 transformer to flow through the moving coil, the direction being such that the relay is restrained under normal circumstances. If a fault develop to earth or between phases, there still being a normal delivery of power to the bars, the increasing fault component of the current in the No. 1 transformer will cause the small local current flowing through the moving coil to decrease. Further increase of fault current will cause a portion of No. 1 transformer's output to spill through the moving coil in the reverse direction, thence through the fixed coil, but in the same direction, as the load current circulating in the system. Reversal of flow through one element constitutes the condition necessary for operating the relay.

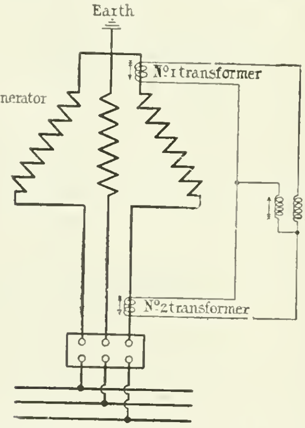

Fig. 2.—Generator Protection with Biased Reactive-Type Relay.

Operation of the Beard System.

If the generator has to contribute abnormal current values to faults on the distribution system, the small local current which gives normal bias will increase and add to the stability of the relay. Fig. 3 shows the general characteristics of the protection given by this scheme, increased sensitiveness being apparent with increasing load. At 70 per cent. load and upwards the relay will operate with less than 2 per cent. fault current.

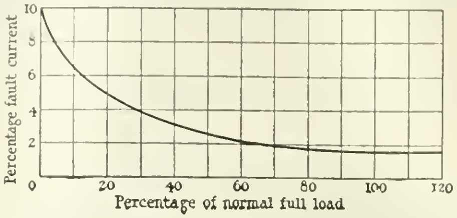

Fig. 3. Curve Showing Fault Current Required to Operate Biased Reactive-Type Relay with Varying Load Current.

In the original Paper various other arrangements capable of dealing effectively with leakages to earth and faults between phases, but ineffective with a breakdown between turns of the same phase which does not develop into either of the preceding forms of fault, are described. Various solutions of the latter problem are also discussed. By a modification of the arrangement shown in Fig. 3 all the requirements can be united in one relay. The unbalance is secured either by inserting resistance in the circuit or increasing the current capacity of No. 2 transformer, so that a local current flows through the moving coil of the relay. The action of a combined differential and reverse current relay is illustrated, and a diagram is presented showing the relation between percentage of bus-bar volts and percentage leakage or reverse current required to reverse the relay.

Objection is sometimes raised to the reverse current relay owing to the liability of the device to become inoperative with lowered potential. An addition to the previous scheme has been made which permits of the device operating if the fault condition is associated with low potentials. The appropriate means to secure this result comprise an auxiliary winding consisting of a few turns wound on the same limb as the potential coil. In a relay of the reactive type this auxiliary coil is connected in series with the current element, the relation of the elements being such that the relay tends to operate.

The Differential System Applied to Feeder Protection.

Of the various systems operating on this principle the arrangements proposed by Merz and Price have been most extensively employed. All these arrangements as applied to distribution systems resolve themselves into one arrangement—the balanced voltage system. On the larger systems the limitations of the voltage balance method have long been realised. Current transformers having air gaps in the iron circuit have been necessary to ensure uniform characteristics between the transformers at each end of the protected lines, and also to keep the temperature of the transformer iron within reasonable limits.

With long feeder lengths capacity current in the pilot wires necessitates the adoption of higher fault settings, placing a limit, with the higher frequencies, on the length of feeder capable of protection. The circulating current system of Messrs. Harlow and Faye-Hansen with alternating-current trip reduces capacity-current troubles to a negligible factor. Employing the leakage current direct, however, without the interposition of relays, raises the percentage protection given by this system. The circulating current system has, for the same transformer voltage, only half the capacity current in the pilot wires that is obtainable with the balanced voltage system.

In a device developed by Messrs. Hunter and Beard to overcome the capacity-current difficulty in the pilot wires with the balanced voltage system, the capacity current which traverses each pilot wire returns by the metallic sheath with which each pilot core is surrounded. The relays are unaffected by the capacity current which flows in the local circuit formed by the metallic sheath and the pilot wires. A fault on the feeder, however, causes the transformers to send their current through one another and through the relays. Another development, in the circulating current system, utilises biased relays. Current normally circulates over the pilot wires and through the elements of each relay and its shunting resistance, the relative flow in the elements being such that the relay remains restrained. If the input of the feeder exceed the output, the additional current forces the load current into the shunting resistance. A portion of the fault current traverses the shunting resistance and flows in one element of each relay in the reverse direction by way of the equipotential lead.

A fault fed from both ends is clearly a case where the percentage bias is not required; the relays therefore for this condition operate without the bias. When the arrangement is applied to a three-phase feeder the primary of the summation transformer carries the sum of the currents of the phase transformers, the secondary delivering single-phase current to the pilot wires.

The Summation Transformer.

The employment of the summation transformer permits of the phase transformers being of normal design and of a ratio suitable for the usual 5-ampere indicating instruments. Some circulating-current systems necessitate the employment of a neutral lead connecting points at equal potential at each end of the pilot wire system, but there are also methods whereby these equipotential points may be obtained without the balancing lead.

A further modification of the biased system which employs the reactive-type relay was shown. One element, preferably the moving coil, is connected in series with the duplicate circuit, the fixed coil being connected between the duplicate and pilot wire circuits. The bias is obtained by making the resistance of the duplicate circuits slightly greater than that of the pilot wires, causing a small current to spill over from the duplicate circuits and flow through the fixed coil of each relay into the pilot wire system; the direction of the spill-over current in relation to that flowing in the moving coil giving normal bias.

In the original Paper several modifications of the arrangement referred to are explained and diagrams are given illustrating feeders protected by lever biased relays and circulating system, and the application of the circulating system with biased relays to a three-phase feeder.

Special Cable Designs

Special cable designs have been developed which in themselves partially function as protective devices. These employ protecting shields round the individual or all of the cores, or leakage conductors embedded in the dielectric. In some forms the inductive effects of the leakage current may be directly employed to trip the controlling switches without the interposition of relays or transformers. Such protective systems may, therefore, be designed to operate with comparatively small leakage currents.

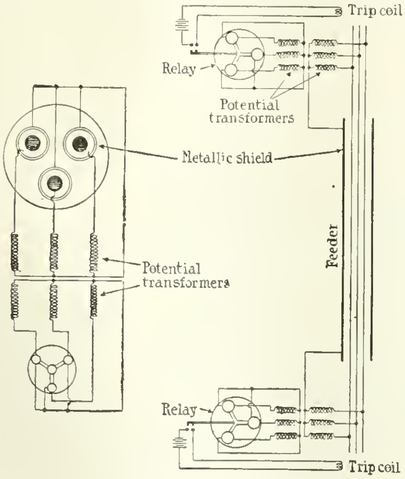

Fig. 4.—Bergmann Protective Cable.

A protective system employing a sheath surrounding each conductor is shown in Fig. 4. This arrangement, due to the Bergmann Company, employs potential transformers connected to the conductors and the surrounding metallic sheath. The secondaries of the transformers actuate a triangularly-spaced centrally-pivoted three-arm relay of the balanced type, the balanced arm tilting over to either side according to which coil, on displacement of the floating neutral, develops the greatest pull. Alternatively, instead of the surrounding sheath the same system provides for a number of leakage conductors surrounding the cores. A somewhat different method, in which the trip coil is placed between each surrounding sheath and the lead covering, due to Mr. Hochstadter, is also described.

Earthing of the Neutral Point and Protective Gear.

With low and medium-pressure systems involving underground cables, present practice tends towards earthing the neutral point. This earthing may be accomplished through a wide range of resistance values, depending on the general extent of the individual system and on the fault settings of existing systems of automatic protective gear. With high-pressure transmission systems other considerations arise and the protective-gear question becomes of secondary importance. Leakage protective or core-balance systems may be designed to operate with fault currents to earth which are small compared with the full-load rating of the circuit or apparatus which they protect. Parallel feeder protection by interlocked overload relays requires relatively large values of leakage current to give definite and correct operation to the protective devices. The leakage current for this class of apparatus may be more than twice the full-load rating of the individual feeder.

DISCUSSION.

Dr. C. C. **Garrard** said Mr. McColl's differential bias system would eventually replace many existing ones. The beam balance relay was very simple and easily adjustable. It was better to alter the bias mechanically whenever possible. The reverse relay was also simple, and there was, in addition, the leakage-protecting relay which operated on the core-balance principle. These relays resembled small ¼ h.p. motors, and could be adjusted by a rough-handed switchboard attendant. The capacity current in the pilot wires was an advantage. It increased stability, and if a pilot wire broke it cut out the cable.

Major K. **Edgcumbe** suggested that the Engineering Standards Association should define some of the terms used such as differential protection, discriminating protection and reactive relay. The Author's system of protection of twin cables by biased reactive type relays cut out both feeders on the occurrence of a fault and presented no advantage over overload protection. In the discussion on his (Major Edgcumbe's) recent Paper, several speakers regarded biasing as a sign of weakness. But it was an advantage in the case of any fortuitous change in the feeders.

Mr. J. R. **Cowie** said in discriminating relay protection with reactive type relays it was assumed that the faulty feeder would carry the excess current. If the fault were at the trifurcating box at the sub-station end all three feeders would take the current. Did the author expect any interference in telephones if the main telephone cable were used with his apparatus ? He thought the author's conclusions as to earthing and non-earthing were sound. Pilot wires should, if possible, not be used.

Mr. E. B. **Wedmore** thought that more should be heard of the Price-Merz protection in the future. Split conductor had limitations, *e.g.*, where there were boosters on the feeders, or where it was desired to protect the step-up or step-down transformers with regulators. He doubted if the system described by the author for overcoming the capacity current in the pilot wires would go far. A solution might be found on the lines of distinguishing between faults to earth and faults between phases. Mr. McColl had been the first to realise and incorporate in his devices the idea of applying a balance system to generators.

Mr. H. W. **Clothier** agreed that there should be some panel to consider the standisation not only of terms but of requirements, to weed out items which were least worth developing, and to direct research and experiment under present working conditions. He had never heard before of the necessity of loading phases unsymmetrically. The term sensitive as applied to relays wanted defining. If the author's relay would act at 15 per cent. of the normal load, that was very good. On Merz-Price voltage protection they were satisfied with making a robust relay operate at 500 amperes on a transformer having 10,000 amperes straight-line characteristic.

Mr. H. **Brazil** said a piece of apparatus was mentioned which would not work on 5 per cent., but would work on 6 per cent. Station engineers did not want new devices if they were not sure they would always be safe. The author inferred that if the current to earth was not sufficient to cut out a generator (or a feeder) the voltage would not send sufficient current through the earthing resistance to cause the automatic device to work. But it was—assuming a fixed resistance. In some cases it might increase, but if there were a negative co-efficient, negative current would flow after a time, when it warmed up.

Major A. M. **Taylor** said overloading in series with Merz-Price arrangements and split conductors seemed to him a weakness. With many branches from a sub-station it was better to have the trunk to that sub-station hold out at all costs than to have an overload relay.

Mr. W. **Wilson** acknowledged a weakness for the beam balance relay. By permitting a small excess current with a small fault setting when the load was ordinary and increasing it to the possible overload he had reduced the fault setting to a very safe value. The author's methods needed no delicate adjustment. With regard to the biased leakage device protecting against unsymmetrical loading, instead of having two relays a single relay might be used with contacts at either end and two fulcra close together in the middle. The author's parallel feeder scheme seemed to have the drawback that the protection was not always secured.

Mr. C. W. **Marshall** thought the circulating-current system superior for existing commercial designs, but there was no fundamental difference from the balanced voltage system. With capacity compensation it was possible to get Merz-Price balanced voltage gear that had as good characteristics as circulating current gear and even split conductor.

Mr. A. F. W. Richards said that a cable was designed by Mr. Beaver in 1912, and described in 1914, in which copper tape was wound round the insulated cores and separated from the lead by paper dielectric. Any leakage from the core was detected by an electrostatic voltmeter placed between the tape and the lead. He had found an incipient fault on such a cable running at 6,000 volts and it was repaired before the cable broke down. Over 100 miles of such cable were in use. On a system in South Lancashire a combination of core-balance and leakage protection was used. A continuous current was superimposed on the sheath and in the event of breakdown it actuated the trip, and the relays being polarised any induced voltages in the sheath were negligible.

The President invited Major Edgcumbe, Mr. Wedmore and Mr. Clothier to write formally suggesting terms of reference to a Committee of the Engineering Standards Association regarding standard of nomenclature and requirements.

Mr. H. W. Clothier, in a written communication, thought that for generator and transformer protection the self-balance system was the simplest and effective in practice, leaving little need for a biased system The maximum "straight through" current which generator protection was required to withstand was the momentary maximum short-circuit current of one generator only. This limited amount could be accurately dealt with There should be no difficulty in securing stability with care in the design and manufacture of the current transformers and relays. The system of "current balance" protection with biased relays was immune from trouble due to pressure variations and phase displacement, but involved a more intricate relay and connections. Combined differential and reverse current relay, whilst providing for additional protection, had the disadvantage of introducing the potential element into the relay. The essential feature in restricting damage to generators and transformers was the rapidity of the isolation of the fault between phases and to earth, and the simultaneous destroying of the main field. The rapidity of operation was of greater moment than highly sensitive fault settings.

The Author intimated that he would reply to comments more fully in writing. He agreed that credit was due to Mr. Wedmore for his development of the bias principle. The devices shown in his Paper illustrating the protection of a feeder by biased relays and a circulating current system eliminated the difficulty of capacity currents in the pilot wire. In his experience more trouble was experienced from induced currents than capacity currents, but with his system it was not necessary to take the latter into account in setting relays. One connection illustrated in Major Edgcumbe's Paper got over some of the troubles. In some cases sheathed conductors were used with the Merz-Price system to avoid trouble in telephone cores. Sometimes many miles of pilot wire and telephone conductors operated on the same core which was not up to P.O. standard but suited power companies. Shifting of the equipotential point depended on the resistance of pilot leads and the capacity of current transformers. If the latter were small the capacity was reduced in ratio. The remedy was to put in bigger transformers and balance the circuit carefully.

Wireless Telephone Progress.

Details of Apparatus Used in Recent Experiments.

The development of wireless telephony in the very early days was so slow that it seemed almost at one time as if the results obtainable would hardly warrant any great attention being paid to this system of communication. A decided fillip to the development was, however, given by the invention of the Fleming valve, while experiments carried out in 1913 by the Marconi Wireless Telegraph Company brought the question into quite a practical category. When war broke out, sets with a range of about 50 km. were actually being manufactured.

In these pre-war sets a three electrode valve and a 500-volt battery were used. Continuous oscillations were generated in a closed circuit, which was coupled to the aerial. The microphone was connected in series with, and at the lower part of the aerial. Since the armistice a large amount of attention has been devoted to new designs and ideas, with the result that corresponding satisfactory progress has been registered.

Among the latest developments we may mention the Marconi 6 kw. telegraph and telephone transmitter, which we illustrate in Fig. 1. This is the set with which the first series of recent interesting experiments in wireless telephony which were duly chronicled in

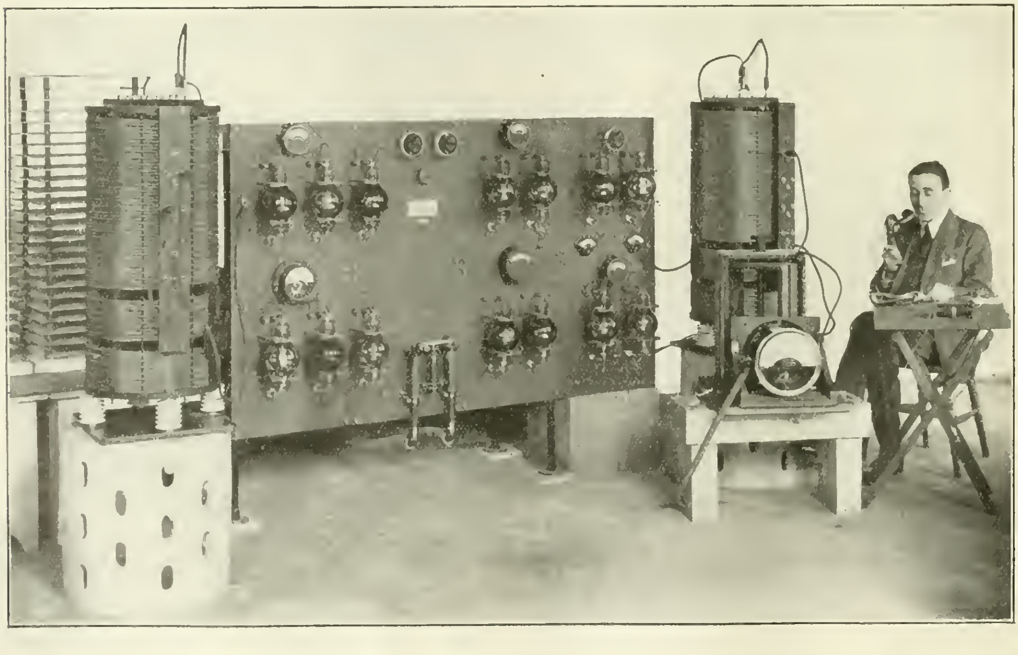

Fig. 1.—General View of 6 kw. Set at Chelmsford.

the daily press were carried out. Subsequently this set was replaced by one with a capacity of 15 kw. working on a wave length of 2,800 metres, of which we give some details below.

Details of the 15 kw. Set.

The generator used in these experiments was a 15 kw. alternator generating current at 500 volts at a frequency of 200. Current from this machine was supplied to the primary side of a 20,000-volt transformer, whose secondary winding was tapped at its middle point as shown diagrammatically in Fig. 2. The two rectifying valves connected to the secondary of the transformer as shown cause the condenser K_1 to be charged to half the total secondary voltage uni-directionally once every half-cycle. This maintains the condenser charge at about 10,000 volts, and thus forms a source of high-tension direct current for supplying the transmitting and low frequency magnifying valves. The arrangement generally comprises two high frequency circuits, $A\,L_1\,E$, which is the aerial circuit, and $L_2\,C\,K_2$, which is the closed circuit. By means of the transmitting valve shown in the diagram, and the reaction coil R, the continuous oscillating current maintained in this latter circuit is transmitted to the aerial through the coupling coil C.

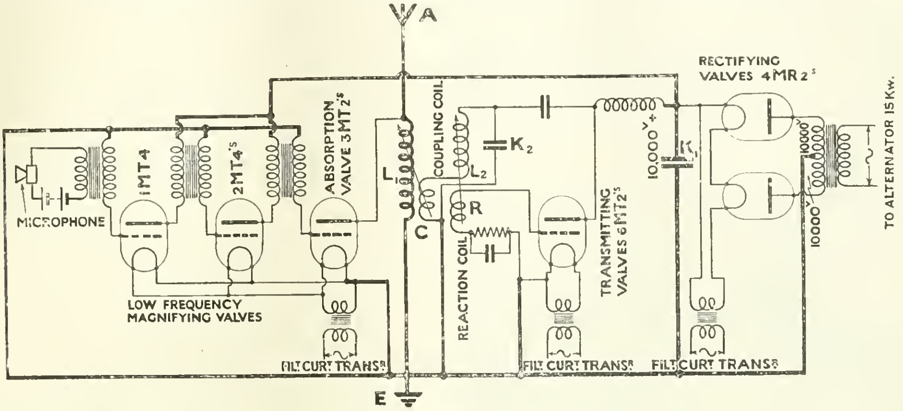

Fig. 2.—Diagram of Connections of 15 kw. Set.

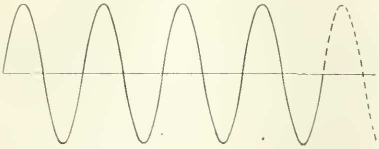

Fig. 3(a).—Continuous or Undamped Wave.

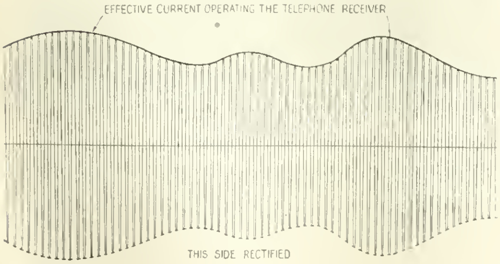

Fig. 3(b).—Continuous Oscillations with Varying Amplitude caused by Voice.

Speech Phenomena.

As mentioned above, a wave length of 2,800 metres is used, the frequency of the continuous oscillations in the aerial being about 100,000 per second. It is obvious that for speech to be heard at the receiving end the wave forms produced at the transmitting end must be superimposed on the ordinary high frequency wireless transmission current. The elementary diagrams which we produce herewith indicate this graphically. The upper diagram shows for clearness the ordinary continuous wireless wave, and the lower the composite wave formed by the combination of this and the waves of varying amplitude caused by the voice. The lower half of the lower curve, which is shown dotted, is of course rectified by the valve apparatus. To eliminate the distortion of the harmonics in the speech waves, and so obtain the best quality speech, it has been found that the best method is to absorb the energy in the aerial in accordance with the speech wave formed.

This is effected by stepping up the microphone current to produce a voltage curve similar in shape to that produced by the varying current caused by speech by means of the two-stage low-frequency amplifier which is shown in Fig. 3. The voltage variations are thus magnified and are impressed on the grids of the absorption valves. As is well known the resistance of a three-electrode valve varies with the voltage impressed on the grid, so that in this case the conducting power of the absorption valves varies with the voltage curve produced by speech.

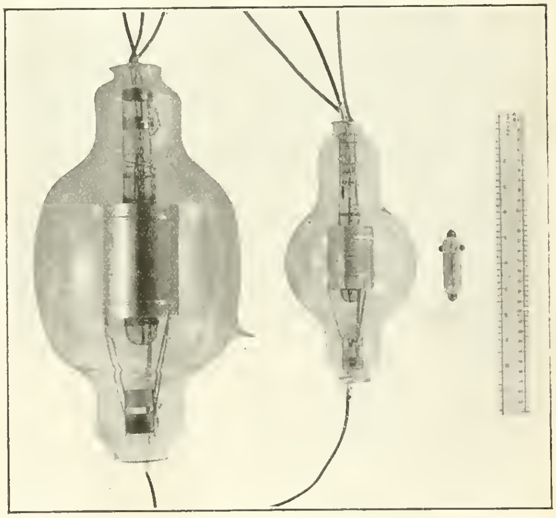

Fig. 4.—General View of Valves Used.

In the present instance, therefore, these valves absorb energy from the aerial in amounts depending upon the degree to which they are made conductive by the voltage generated by the impressed speech, owing to the fact that they are connected across the aerial tuning inductance. This energy is dissipated in heat in the valves themselves, so that they must be large enough to prevent any ill effects from over-heating.

DETAILS OF APPARATUS.

The *MT2* and *MT4* valves are illustrated in Fig. 4, an approximate idea of their dimensions being obtained from the foot rule placed alongside. The construction of these valves is similar to that of the ordinary three-electrode receiving valve, though they are, of course, much larger.

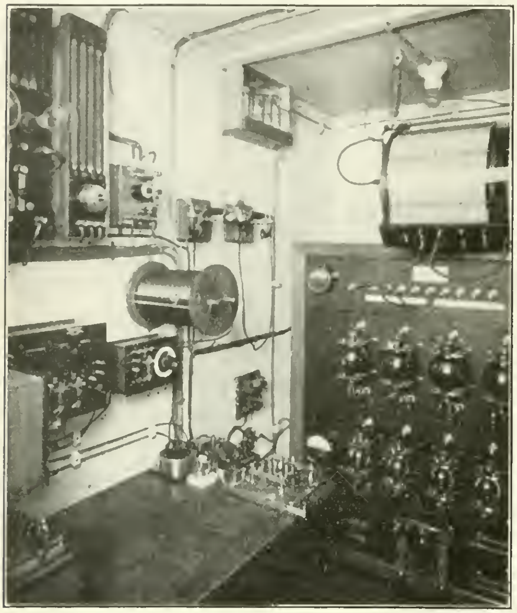

FIG. 5.—3 KW. VALVE TRANSMISSION SET.

Their resistances are also higher, as they have to withstand higher voltages. The vacuum is also raised to as high a degree as possible by means of the most modern exhaust pumps. The valve filaments are made of tungsten, and the anode and grid are of nickel. Fig. 1 shows the arrangement of the valves during operation. Six transmitting valves of type *MT4* are mounted on the left side of the panel; the four middle valves are the rectifying valves type *MR4*, while of the *MT4* valves on the extreme right side of the panel three are absorption valves and one is a low-frequency magnifying valve. In this case the low-frequency amplifier employed has one stage only. In the middle of the lower half of the panel is fixed an electromagnetically operated signalling switch which is employed for keying when the set is used for continuous wave telegraphy. Fig. 5 gives a closer view of a 3 kw. valve transmission set which is installed on some of the large liners.

A Half-Million Volt Condenser for Testing Purposes.*

In order to provide facilities for high-voltage tests of insulators there has been built at Palo Alto, Cal., U.S.A., an air condenser on which tests have been made with voltages up to 500,000 and frequencies up to 60,000 cycles, continuous oscillation. So far as is known, this is the highest voltage equipment of its type ever built. The condenser proper is contained in a structure consisting of a wooden frame of studding and rafters lined on the inside with corrugated galvanised iron. Immediately in front of the doors a concrete paving has been laid over an area of about 20 ft. by 35 ft., and it is in this space that the tests are made. In view of the favourable climatic conditions in this locality it was no disadvantage to make tests in the open air. On the other hand, there was distinct advantage in the ample clearances insured by having the condenser housed by itself.

The two plates of the condenser are horizontal, the lower one fixed and the upper one movable. The lower plate is built up of two parallel sheets of copper 2 ft. apart and connected along the edges by copper sheets curved on a 12 in. radius. To support the copper sheets in the shape desired a wooden form was first built up with edges carefully rounded to the desired curve, and the sheets were tacked to the wood and joints soldered. The copper plate of the condenser is supported on 9 ft. piers made up of 4 in. porcelain insulators cemented together in layers, successive layers being separated by sheets of iron. These iron sheets were inserted to increase the stability of the structure.

The upper plate, 15 ft. by 30 ft. in size, consists of galvanised sheet iron on a wooden frame supported on wire ropes running over the tops of the walls to counterweights on the outside of the structure. By means of a hand-operated winch the upper plate can be raised or lowered to give any desired spacing between the two plates up to a maximum of 4 ft. 5 in. The movable plate is electrically connected at all times to the galvanised lining of the house, which is thoroughly earthed. A Poulsen arc (30 kw.) converter supplies energy for the tests. One side of the arc is grounded while the other is connected to the insulated plate of the condenser through a coil of Litzendraht, 9 ft. long and 31 in. in diameter. This coil has an inductance of 21 millihenries. The coil stands upright on the concrete beneath the copper plate, and its upper end extends through a hole in the lower face of the plate. Thus, by making connection on the inside corona effect is avoided.

For convenience in testing, a projection termed the "turtle neck" has been built to extend from the copper plate 15 ft. or 20 ft. beyond its end, thus permitting the arrangement of materials to be tested in the ample space on the concrete pavement in front of the housing. This "turtle neck" consists of a 10 in. sheet-iron pipe made up in outer sections similar to the usual method of making stove-pipe. Its short end has been rounded off with approximately the same radius as the pipe itself, and its inner end extends between the two faces of the copper plate through a hole provided for that purpose.

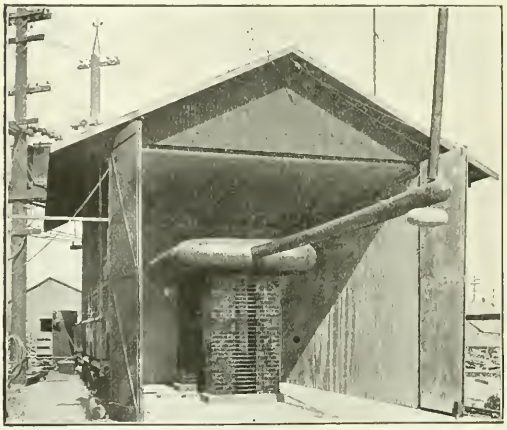

FIG. 1.—HOUSING FOR 500,000-VOLT AIR CONDENSER.

The "turtle neck" is not permanently attached to the copper plates, and can be slid in or out to secure the length desired. When the "turtle neck" is not in use the aperture provided for it in the end of the condenser is closed with a curved plate to prevent corona discharge from the edges of the hole. Tests are ordinarily conducted between the outer end of the turtle "neck" and the ground. Where an insulator is to be subjected to high-tension tests it is hung from a pole near the entrance to the condenser house. The upper end of the insulator is electrically connected to the "turtle neck" while the lower end is grounded. With the apparatus so arranged any pressure up to 400,000 volts or 500,000 volts, depending upon atmospheric conditions, can be, impressed upon the lower plate of the condenser, and the frequency can be regulated up to about 60,000 cycles. The capacity of the condenser is limited by the dielectric strength of the air between the lower plate and the nearest ground. Under full potential of 500,000 volts and with the "turtle neck" withdrawn, the lower plate arcs to earth, a distance of 9 ft.

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* Abstract of an article in the "Electrical World."

Telephone Repeaters.*

By B. GHERARDI and F. B. JEWETT.

(Continued from p. 544.)

THE COURSE OF THE TELEPHONE CURRENT.

Let us now follow the telephone current, assuming that it is travelling from west to east. The current that comes to the repeater from the west is partly transmitted through the circuit to the line east, but the larger part of it is divided between the input and output circuits of the telephone repeater element. The energy which flows into the output circuit is merely dissipated. The energy which flows into the input circuit is amplified by the repeater element and the amplified current passes to the "output coil." At this point if the line west and the line east are similar in characteristics the energy divides, half going to the east and half to the west. The half that goes west, that is, towards the direction from which the transmission came, serves no useful purpose. The half that goes east (combined with the small amount of energy that passes directly through the repeater) may be many times larger than the original energy coming from line west and is the useful amplified transmission.

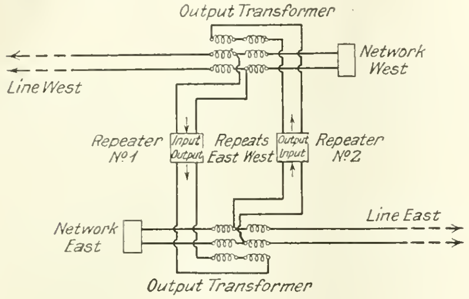

FIG. 13.

When the lines west and east are identical there is no voltage set up across the input circuit, and, therefore, no possibility of a "singing" condition no matter how large amplifications are employed. This circuit therefore permits two-way transmission over similar lines.

In case, however, the line west and the line east are different in their impedance characteristics for any part of the telephone frequency range, then for such frequencies there will be voltages set up across the input circuit due to current flowing from the output circuit and a tendency towards singing and distortion. The conditions which hold when such unbalances exist will be discussed later.

The duplex bridge circuit is applicable as a terminal circuit whereby two-way transmission may be had over a single pair of wires. The telephone line is balanced by the inclusion in the opposite arm of the bridge of an artificial line of similar impedance-frequency characteristic. At a repeater station we may, therefore, terminate both incoming lines by bridge circuits, balance each line by an artificial line, and operate both lines as a through circuit for two-way conversations provided we connect the input branch of each bridge to the output branch of the other. In connecting the input terminals of one bridge circuit to the output terminals of the other bridge circuit we may introduce a one-way amplifier as shown in Fig. 13.

THE "22-TYPE" CIRCUIT.

The resulting circuit is the 22-type defined above. This circuit makes use of a separate repeater element for transmission west to east from that used for transmission east to west, and it requires two "output transformers"; each line, instead of being balanced by the line in the opposite direction, is balanced by an artificial line indicated as "network west" or "network east." Assuming again the transmission to be coming from the west, we trace the currents through the repeater circuit as follows: A small part of the energy goes through the network west; the largest part, however, is divided between the input circuit of repeater No. 1 and the output circuit of repeater No. 2. That part which enters the output circuit of repeater No. 2 is dissipated without doing useful work. The part reaching the input of repeater No. 1 is amplified and the amplified energy flows through the output transformer connected to line east. The "network east" is made to have as nearly as possible the same impedance as the actual line for the full range of telephone frequencies. If the balance were perfect, there would be no voltage whatever set up across the input circuit of repeater No. 2, and therefore no possibility of setting up a singing condition whatever values of amplification were used.

Actually the balance can never be absolutely perfect, so that there will be a certain voltage set up across this input. This will, in turn, be amplified by repeater No. 2. These amplified currents will then flow through the output transformer connected to the line west. If the "network west" has exactly the same impedance as the line west, then the energy will equally divide between the two and there will be no voltage set up across the input circuit of repeater No. 1. This condition will then prevent any possibility of a singing condition being set up. This circuit is, however, very much more stable than the 21-type circuit, if either of the networks exactly balances its line, there may be any degree of unbalance between the other network and its line without permitting singing.

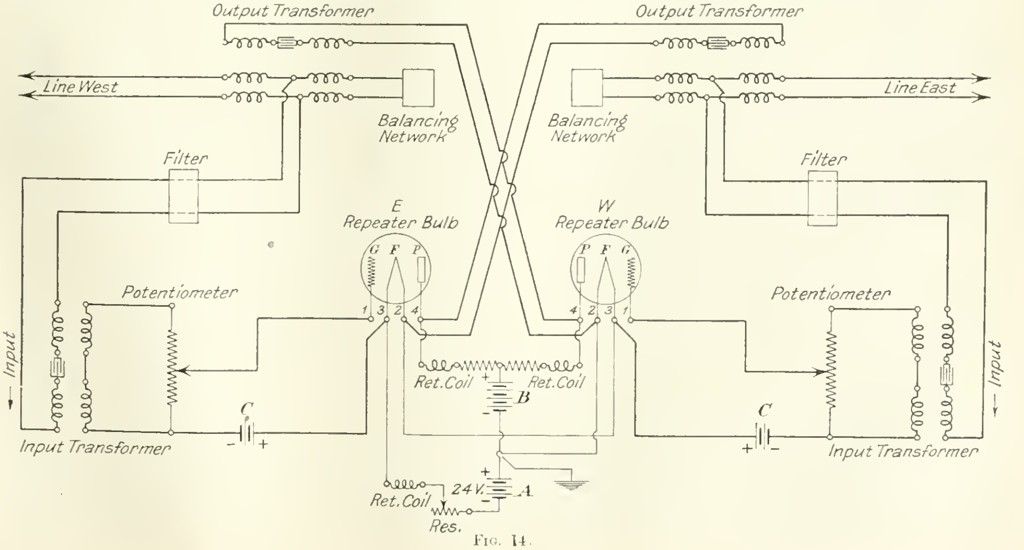

FIG. 14.

There is another property of the 22 type circuit which is of great importance in connection with tandem operation of repeaters. As pointed out, transmission coming from the line west and reaching a 21-type repeater, as in Fig. 11, will result in an amplified current being sent out towards line east; but also in an equally large current being sent back into line west. In the case of the 22-type however, if the transmission comes in from line west and the balance between network east and line east is good, there will be very little energy sent back into line west. This is a great advantage as the energy sent back into line west would react on any other repeater which was in circuit in that direction. A 22-type circuit with vacuum tube repeater elements connected into it is shown in Fig. 14.

Balancing of Lines.

Assuming that we have repeater elements which can give us sufficient amplification without appreciably affecting quality the amount of amplification which we can get in any practical case depends on the degree to which balance condition of lines can be carried. It is the line conditions, rather than the repeater element or its circuits which finally limit in every practical case the amplifications obtainable.

Let us consider, therefore, what the impedance of a telephone circuit looks like as seen from the repeater terminals.

Telephone Line Impedance.

If we take a very long No. 8 B.W.G. open wire circuit, which is the largest size of copper in general use in the telephone art, and suppose this circuit to be absolutely uniform in its characteristics, then its impedance, that is, the ratio of the voltage applied across it to the current entering it will be as shown by Curves 1 and 2 in Fig. 15 in which curve 1 gives the resistance and curve 2 the negative reactance of the impedance.

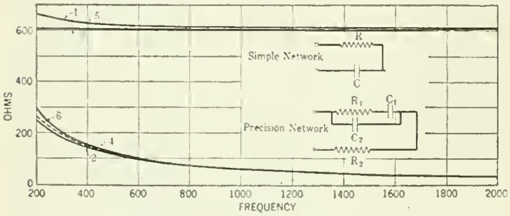

Fig. 15. Non-Loaded No. 8 Gauge Open Wire Lamp.

For such a line we can make up a very simple form of network which was approximately the same impedance and can be used for balancing in a repeater circuit. Curves No. 3 and 4 indicate the impedance of a network consisting merely of a condenser in series with resistance. Even this simple circuit is a good approximation of the impedance of a long line except at low frequencies. Curves Nos. 5 and 6 show the impedance of a somewhat more complicated network, as indicated on the diagram, which gives a very good approximation over the whole telephone frequency range. In practice every line has slight irregularities which affect somewhat its impedance. It is difficult, however, to keep a long open-wire circuit free from short stretches of cable. If a line has many irregularities, the setting up of a balancing network, while always theoretically possible, would become very expensive and inconvenient. A fundamental requirement, then, in obtaining good repeater action on a line, is the maintenance of a high degree of uniformity in the electrical characteristics.

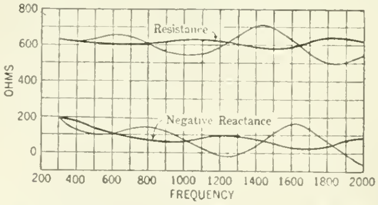

Fig. 16.—Harrisburg to Pole 400 Newark, Wires 23/24 Coil in at Easton.

In some cases the irregularity caused by the cable can be largely overcome by inserting in the cable one or more loading coils to make the impedance of the cable approximately that of the open-wire line. Fig. 16 shows the result of cutting a single coil into the mid-point of a line 165 miles long but containing 1¼ miles of underground cable. In this figure the curves, after loading, are shown in heavy lines, and the old curves are indicated in lighter lines for comparison.

In the case of loaded lines, the problem of maintaining sufficient regularity in the electrical characteristics to give a satisfactory impedance curve becomes considerably more difficult, due to variations in the inductances of the loading coils and in the distances between these coils.

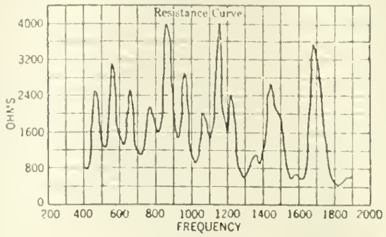

Fig. 17.—Section of Transcontinental Circuit Pittsburgh to New York before "Clearing Up."

Fig. 17 shows an impedance characteristic of an open-wire line loaded at approximately 8-mile intervals with loading coils having approximately ¼ henry each. This circuit would give commercial service from a transmission standpoint; but its impedance characteristic is extremely irregular, and it would be difficult to obtain gains from a telephone repeater operated in conjunction with it.

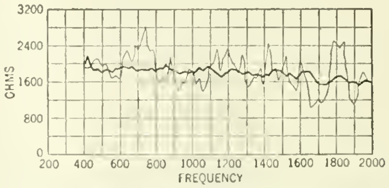

Fig. 18.—Section of Transcontinental Circuit Pittsburgh to Chicago after "Clearing Up."

Fig. 18 shows the resistance of a circuit of similar constants representing a less extreme condition of irregularity. This would have been considered, before the advent of repeaters, a reasonably good circuit so far as irregularity is concerned. These irregularities were due largely to comparatively small variations in spacing of loading coils and in the inductances of the loading coils. Loading coils have to be placed on a telephone circuit at particular points in the transposition layout of the circuit in order to prevent crosstalk between it and other circuits on the same lead. It is difficult, however, exactly to space transpositions in view of the variations in the route taken by a line, lengths of cable, junction points with other lines, &c. This led in the past to variations in the lengths between the successive loading points. Aerial loading coils are exposed to current surges due to lightning, and with some of the types of coils which have been put into use this has led to variations in their inductances. For any given frequency, it may be that the effect of a large number of such irregularities are cumulative in raising the impedance of the circuit for that frequency, whereas with another frequency only slightly removed from the first, the effect of the irregularities may be to reduce the impedance. The result, then, with such impedance is indicated in Fig. 18, where the variation was due, not to a few large irregularities, but to a large number of small irregularities.

This particular circuit was one of those entering into the transcontinental line, so that it was very carefully gone over, re-transposed where necessary, the loading coils replaced by others having a particularly high degree of stability and uniformity, and the spacings made very uniform. The dark line shows the impedance after this work had been done, and the light line the nature of the conditions before "cleaning up." The circuit will now permit of large gains with repeaters.

In cases where a large variation in impedance is due to one or more large irregularities, the impedance curves often offer a very interesting and convenient method of determining the point at which irregularity exists. For example, assume that the impedance of a circuit as measured from one end shows a large wave-like variation, due to defective apparatus at some point in the circuit. By measuring the frequency range between successive "humps" on this "wave" it is possible to determine the distance from the sending end to the point of irregularity. In practical work, many cases have arisen where omitted or defective coils or other irregularities have been located in position by this method.

In maintaining this uniformity of the characteristics of the line, one of the largest difficulties is caring for short lengths of cable which may occur in the line at river crossings, in going through towns, &c. It has sometimes been difficult to explain to those outside of the telephone field, but who are acquainted with the fact that by loading and telephone repeaters we can talk through long lengths of cable, why it is that we have so much difficulty with short lengths of cable which come into our open-wire circuits, and why we are averse to cutting such short lengths into important long-distance lines at villages and at crossings of railroads, power lines, &c. Considering, however, that a 500-ft. length of cable has as much capacity as three-quarters of a mile of open wire, it is evident that even a short length of cable has a very large effect on the operation of any repeater on the line. In laying out a circuit, such short lengths of cable can be partially corrected for in the spacing of the loading coils. Changes made after a line is laid out are, of course, much more difficult to take care of.

(*To be concluded.*)

Reviews.

"Standard Tables and Equations in Radio-Telegraphy." By Bertram Hoyle, M.Sc. (London: The Wireless Press, Ltd. Pp. xiv.+159). 9s. net.

The object of this book is stated in the Introduction. "The author has had in view the object of extending the scope and number of equations and tables given in the 'Year Book of Wireless Telegraphy'. . . . No such complete book of tables and equations exists, for the specific use of wireless engineers or others, under a single cover, which is the author's excuse for putting these into the present form." The quality of such a compilation—whether or no the second sentence of this extract is correct—is to be judged mainly on three counts: the comprehensiveness of the collection, the intelligibility and accuracy with which the information is set out, and the accessibility dependent on arrangement and indexing.

The present volume shows more favourably in respect of the first than the second and third of these counts. The information contained in it covers wide ground. Some of the usual mathematical tables are given; there are tables of weights and measures, decimal equivalents and conversion factors; tables of specific physical properties; various calculated tables, such as, for resistances of conductors, and for catenary dips; tables of wire gauges, screw threads, and the like; and even tables of some standard forms for pipe-bends and shackles, and of the constitution of solders and soldering fluxes. In addition to this general matter there are various wireless formulæ for inductance, co-efficient of coupling, damping, &c., supplemented by numerous tables designed to simplify the numerical calculations.

The book is divided into four sections. Section I. consists chiefly of theoretical formulæ, mainly wireless; but it also contains matter one would look for in Section II. or IV. such as names and C.S.G. values of the practical electromagnetic units, and a table of strengths of woods and metals. The author says in the Introduction that "a special point has been made of giving in every paragraph dealing with an equation a list of the meanings and units used in that equation," so that the original formula may be reproduced without change. The result is not altogether happy. The list of symbols is often incomplete; some occur under Formula and some under Notes; and proximate formulæ have the appearance of conflicting, as on page 14, where one author's decrement δ immediately follows another author's half-decrement δ, and on page 13 where "ρ=specific resistance in ohms per cm. cube" is followed by an expression involving a symbol σ not otherwise explained than by "$\sigma=1600$."

Section II. contains the mathematical tables, the tables of functions accessory to the wireless formulæ of Section I., and some of the tables of physical properties. Others of the last, however, are in Section IV. Weights and measures are given in Section II., but their conversion tables and factors are in Section IV.

Section III. consists of examples and explanatory notes on the use of the formulæ of Section I., and is a good feature of the book. But here again the seeming lack of system is evident. Various abacs are included, which one would expect to find in Section II. with the tables serving similar purpose. It often happens, in fact, that in order to make a numerical calculation one has to refer to three separate portions of the book, even the meanings of symbols in the formula sometimes being discoverable only by examination of the example in Section III.

Section IV. consists mainly of various non-electrical tables.

There is much useful and diverse information to be extracted from the book, but it is shrouded in a good deal of obscurity of form, and signally fails in being a work of easy reference. There are too many type-setter's errors, such as Notes being set opposite Formulæ to which they do not belong, while many of the two-page tables are inconveniently placed on the two sides of a single leaf. A rather drastic re-editing and more careful proof-reading seems desirable, and a few dimensioned diagrams (shapes of inductance coils, &c.), might with advantage take the place of wordy descriptions. L. B. T.

General Lectures on Electrical Engineering. By C. P. Steinmetz. 5th Edition. (London: Hill Publishing Company.) Pp. ix.+242. 12s. 6d.

Since the first appearance of this book in 1908 electrical engineering has advanced very materially in certain directions, and thus the present edition (the fifth) has been modified to take account of such advances. The alterations are particularly noticeable in the lectures on long-distance transmission, higher harmonics, lightning protection, arc lighting, and the incandescent lamp. In the last-named an interesting discussion is given of the conditions on which the efficiency of the incandescent lamp depends and the way in which it has been raised by modern methods. An additional lecture has been included on modern power generation and distribution. The first edition contained two appendixes, one on light and illumination, and the other on lightning and lightning protection. These have now disappeared, but there is an appendix in which is given the author's address, delivered before the Franklin Institute, on the "Effect of Electrical Engineering on Modern Civilisation." There is also a further appendix giving tabular data on overhead lines.

The lectures are brief. They are not abstruse and they could be read by any student with advantage, as they deal in a sound way with general principles.

Whittaker's Electrical Engineers' Pocket Book. Founded by Kenelm Edgcumbe. Edited by R. E. Neale, B.Sc. Fourth edition. (London: Sir Isaac Pitman & Sons, Ltd.) Pp. 671. 10s. 6d. net.

The publication of the fourth edition of this well-known pocket book is accompanied by several changes. Major Edgcumbe, the founder and editor, is succeeded by Mr. R. E. Neale, and since the last edition was published the business of Messrs. Whittaker & Company has been absorbed by Sir Isaac Pitman & Sons, Ltd. The volume has expanded from 598 pages to 671 pages, and the price has been increased from 5s. to 10s. 6d. net. This is an increase to which no objection can be made, as the book has been entirely re-written, and paper, binding, publishing and labour costs have all risen unconsciably since 1912.

Of electrical pocket books this is the best. It is the Molesworth of electrical engineering, and one of its few disadvantages is that it is not a pocket book, though it will go easily into the attaché case which is now becoming part of the everyday equipment of the electrical engineer. It is well printed and bound.

The wise course has been taken of obtaining the assistance of a number of specialists to write on their own subjects, and the general aim has been not merely to give a number of formula collected from various sources and often of a contradictory nature, but to furnish an up-to-date synopsis on each subject. The work in general has been well done, and the editor is to be congratulated on his labours.

The one great lacuna is that no mention is made of wireless telegraphy and telephony, though the pocket book purports to cover the whole field of industrial electrical engineering. Other "weak current" work such as telegraphy and telephony is similarly neglected, and the space given to heating and cooking and to electric welding might well be expanded. The section on lighting will certainly require revision for the next edition. The switchgear section is good. This, we remember, was a feature of the earlier editions, but attempts might be made to standardise and to increase the size of the illustrations. Attention was called to this in our review of the third edition, but little or no improvement has been made. A useful feature are the numerous references to current literature on the various subjects. In spite of these minor failings, which we hope will receive the attention of the editor, the book has much to recommend it.

Heating and Cooking Notes.

AN "XCEL" TABLE COOKER.

The success obtained with the "Xcel" iron has encouraged its makers to produce another household utility electrical appliance in the form of a table cooker. This cooker can be used for a number of operations, such as frying, grilling, boiling, toasting, two of which can proceed at once.

Fig. 1 shows the complete cooker, consisting of a pan, grill and deflector plate. The pan is stoutly constructed of sheet metal and has a removable handle, whilst the grill plate consists of a perforated sheet metal disc having three stamped projections of semi-spherical shape which act as feet. The plate is, therefore, above the level of the base of the pan so that fat can run through to it from the grill plate. The deflector plate can be placed above or below the element as desired, or omitted when two cooking operations are being carried out at the same time. The element is of spiral form carried on mica insulation pieces and is mounted in a circular frame. The replacement of a faulty spiral is an easy matter which involves the loosening of only two screws.

The loading is 600 watts, which is sufficiently low to permit the apparatus being used off a lampholder in the majority of cases. Being a radiant element ordinary cooking utensils can be employed. An adequate guard protects the terminals from accidental contact, and a substantial connector with flex strain device is provided. The apparatus is well finished and, being carefully made and designed, is a welcome British-made piece of apparatus.

THE CRESSALL MANUFACTURING COMPANY.

The Cressall Manufacturing Company not only manufactures a range of utensils in the form of irons, hot-plates, kettles, milk boilers, &c., but also offers manufacturers of electrically-heated apparatus, and users, a series of standard elements. We have often advocated that heating elements should be made to standard sizes, so that replacements could be easily effected, and it is therefore pleasing to note that this firm is endeavouring to meet this demand.

There are many small industrial processes to which electric heating can be applied, for which the apparatus required is often of a special nature. Under present conditions, therefore, manufacturers are not enthusiastic over receiving inquiries and quoting for small quantities of apparatus of special design. Given an element, many an electrician or engineer in charge of an industrial plant can adapt his own apparatus to electric heating. Such an adaptation will, in many instances, be quite satisfactory, and a very much quicker method than waiting for a manufacturer to design and make a special piece of apparatus.

The "Cressall" elements essentially consist of a nickel-crome wire or tape wound upon a mica former. The wire or tape is corrugated with a view to taking up the expansion which occurs when the element attains its normal working temperature. All connections and contacts are made of pure nickel ribbon. The standard patterns are shown in Fig. 2.

Type A ranges in loading from 125 to 500 watts, and in length from 5 in. to 9 in., a uniform width of 1¼ in. being employed. It may be noted that these elements comply with Admiralty requirements.

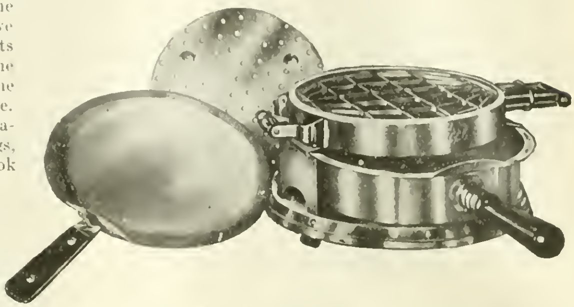

FIG. 1.—VIEW OF THE "XCEL" COOKER.

Type B is of the correct size for replacing elements in "Prometheus" convectors. They are fitted with protecting and insulating micas and flat end contacts for fitting into clip contacts. Types C and D are unprotected and are fixed by means of No. 2. B.A. screws, eyeletted screwholes being provided. Type E are similar to C and D, but provided with strip nickel contacts, whilst type F, as their shape indicates, are suitable for domestic irons. Types C, D, and E range in loading from 50 to 250 watts, and the iron elements, type F, from 200 to 500 watts.

These standard elements are designed for use on the following voltages: 100/110, 200/220, 230/250, but at slight extra cost elements will be supplied suitable for special loadings or voltages. By mounting a number of the convector type elements on a girder iron frame, and employing porcelain or fireclay insulators, a suitable heating unit can be built up for use in drying cabinets. Adequate sub-division of the element circuits and the use of series parallel rotary switches will provide an exact degree of temperature control. The construction of the element frame is a comparatively easy matter, and where necessary it can be designed to fit an existing cabinet.

It is to be hoped that supply authorities and contractors will realise the field that exists for the development of the use of electric heating in industrial processes, and make use of the facilities in this connection which the provision of standard heating elements provides.

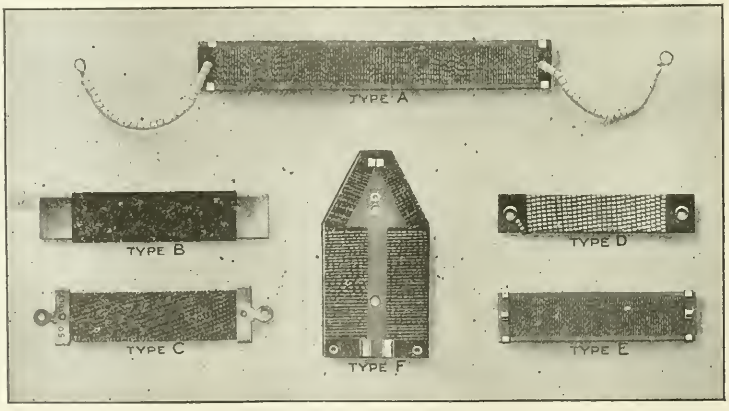

FIG. 2.—CRESSALL ELEMENTS.

"Lorival."

We recently inspected a new type of moulded insulated material which we understand is the result of several years' experiment and the expenditure of a large amount of capital. It is now being placed on the market, and it has already received certain interesting industrial applications. This material, which is known as "Lorival," possesses some very interesting properties, both electrical and otherwise.

"Lorival" is of a reddish colour, and has a natural, highly-finished appearance, which not only should add to its selling value, but has the advantage that little work has to be carried out on it after leaving the mould to make it suitable for marketing. It is non-porous and non-hygroscopic, and has a specific gravity of 1·23. It is easily machined without any permanent injury to the tools. Ordinary tools may be used and the work carried out exceedingly rapidly, owing to the fact that there is little heating. It is interesting to know that it gives a continuous shaving. We understand that it does not soften or crack with heat, but only carbonises at a high temperature. It is quite non-inflammable.

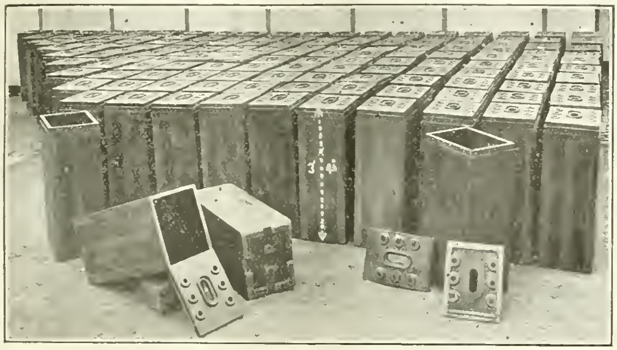
Fig. 1.—Large Accumulator Containers Awaiting Dispatch.

As indicated by our illustrations, articles of various sizes and almost any shape can be moulded in this material, and specially interesting in this connection are very large accumulator battery boxes, shown in Fig. 1, which have recently been made up to special designs for carrying the accumulators employed for driving submarines. These containers are cast in one piece, the cover only being made separately. The moulded bayonet fitting shown in Fig. 3 is also a useful and cheap article in these days of porcelain shortage.

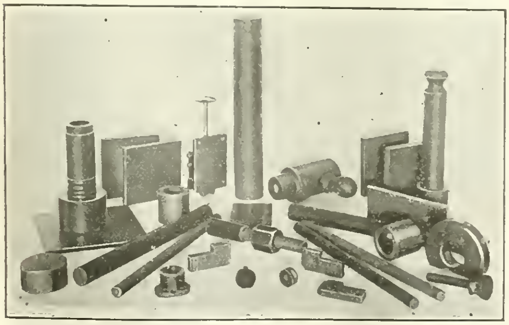
Fig. 2.—Miscellaneous Lorival Articles including Magneto, Distributor, Rod Sheet, etc.

Electrically, the dielectric strength of "Lorival" is high, and we understand that a breakdown voltage of 7,000 volts per mm. has been obtained, a figure which it is hoped to improve. It is resistant to acid, and its strength is claimed to be greater than that of any other phenol condensation product. It has a high resiliency, which is well illustrated by dropping a rod or plate of the material on a stone floor. This test also illustrates the strength of "Lorival," as it is claimed it is very seldom, under such conditions, that even a thin plate breaks, though there may, of course, be slight chipping. It should be noted that, in case of breakage, it is possible to weld a new piece of material into the article without any reduction in the total strength and without detracting from the appearance.

"Lorival" is, it is claimed, also capable of taking a highly polished varnish, and research work is now being carried on in regard to the dyeing of the material. Success in this direction has already been achieved, and amongst other colours a pleasing blue and scarlet can be produced. We are not permitted to say very much about its manufacture, but the following general details will doubtless be of interest: The basic phenol condensation product in the manufacture of this material is brought to a moderate temperature, and when at this temperature special catalysts are added. At this temperature the viscosity of the mixture is about equal to that of olive oil, so that it can be easily poured into open moulds for the casting. After pouring, the material is kept constant at the above-mentioned temperature, the effect of the catalysts then being gradually to bring about solidification of the mass, until a stage is reached when the moulding can be safely handled, although it is still slightly plastic. It is then removed from the moulds, and receives two bakings, the effect of which is both to harden and strengthen the product. It has then reached a stable condition, and, as mentioned above, further heating does not cause the material to melt, but simply to char.

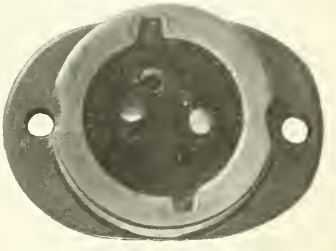
Fig. 3.—A Lorival Lamp Holder with the usual Bayonet Socket.

This material is now being made at Watford by the Lorival Mfg. Company, who are specialising in the manufacture of the larger size accumulator containers. The use of this material for this class of work obviously offers many advantages over the more usually employed lead and glass.

We understand that a further site has been acquired by the Company at Southall, where building operations are shortly to be started for the erection of an extensive factory. The Lorival Mfg. Company will always be pleased to see anyone who is interested in insulating materials at their offices at 6, Lloyd's-avenue, E.C. 3.

Royal Society Soiree.

The Royal Society held the first of this season's soirées at Burlington House on Wednesday, May 12th, when Sir Joseph J. Thomson, O.M., P.R.S., received the guests. As usual, a feature of the gathering were the scientific exhibits, though it was obvious that in this sphere, as in many others, the effects of the war are still being felt.

There was very little of direct electrical interest, though special mention must be made of a demonstration of radiotelephony by Mr. A. A. Campbell Swinton, F.R.S., in connection with Marconi's Wireless Telegraph Company. Signals and speech were received from Chelmsford, where a 15 kw. plant provided with a 450 ft. aerial mast is installed. On another page of this issue we give some account of the transmitting apparatus. The receiving apparatus consisted of a wooden frame 3 ft. square, on which a few turns of wire were wound, a tuning condenser, a set of five triode amplifier valves in cascade, a sixth valve serving as a rectifier and double note amplifier, together with loud speaking and other telephones, which allowed the sounds to be made audible both to the whole room and to individual listeners.

Some X-ray exhibits were shown by Major G. W. C Kaye Details of the preparations of similar exhibits were dealt with in our issue of Feb. 6th. One of the most interesting shown on this occasion was a steel block 2½ in. in thickness through which the R.D. marking on one side could be read quite plainly, while those showing shells and fuses also attracted attention. Major Kaye also showed that X-rays have received equal application in exposing spurious Old Masters, and in showing up flaws in aeroplane struts.

A series of experiments in rotational dynamics were shown by Mr. Charles R. Gibson, F.R.S.E., on behalf of Mr. Joseph Gould. These were a development of earlier experiments with vibrating bars, the mos remarkable of which is the vortex effect which was demonstrated in 1896. The new experiments show a rotational effect which is independent of the vortex phenomena. A light clamp is fitted across a steel bar, and carries an upright needle, upon the free end of which is placed a light metal cap. If the bar is set in vibration the cap rotates at considerable speed, owing to the interplay of two systems of vibration at right angles to each other. The explanation of this given by Mr. Gibson is that there are two principal systems of vibration, the normal, in which the nodal lines lie across the surface, and the vibration is transverse from end to end of the bar, and the dual, in which the nodal line divides the bar in two throughout its length, and the vibration is transverse across the width of the bar. These simultaneous motions are communicated to the cap in the form of an ellipse, thus causing it to rotate.

An optical indicator for internal combustion engines was shown by Prof. F. W. Burstall. The arrangement consisted of two mirrors, one of which was mounted above the indicator piston, and recorded the pressure variations, while the other recorded the engine stroke. The mirrors were so set that a beam falling on the first is reflected to the second and thence on to a ground glass screen or photographic plate. A "Pointolite" lamp was used as the source of light. The spring control of the piston consisted of a steel cantilever arm, which being very stiff has a short period of vibration. The indicator has proved satisfactory up to pressures of 600 lb. per square inch and 2,500 revs. per min.

The Hon. Sir Charles Parsons showed a water hammer cone, which he described in connection with his Paper on "Propeller Erosion," read before the Institution of Naval Architects last year.

Mr. E. A. Reeves showed apparatus for indicating the existence of true north and south direction forces in atmospheric electricity. This consists of an electroscope made of two pieces of gold paper about an inch wide, which are suspended by a fibre of unspun silk within a glass jar. This jar is closed by a rubber stopper and varnished with shellac outside and inside to improve the insulation, and is mounted on a tripod, in the open air, but is protected from the direct sunlight. When the electroscope is charged in the usual way it will within 20 minutes or so come to rest in such a position that the mean plane between the paper foils passes through true north. Records taken with the instrument show that it is very accurate. The greatest deviation obtained with it was 2·5 deg. during one of the recent magnetic storms

Mr. A. Mallock showed an apparatus for determining the variation in the rigidity of materials with the temperature. The specimen forms part of a torsion balance system, and the change which it undergoes is recorded on a chronograph which by means of 16 electromagnets can deal with 16 events simultaneously.

The Admiralty Compass Department showed some recent developments in magnetic compasses. The needle is immersed in alcohol, and is provided with a number of long filaments projecting round it, which damp its oscillations and bring it to rest without swinging to or fro on each side the north.

Some clays treated by electro-osmosis were shown by the Osmosis Company, Ltd.

Electricity Supply in Blackburn.

An interesting ceremony in connection with the development of electricity supply in Blackburn took place on Thursday in last week, when the foundation stone of the new generating station at Whitebirk was laid by Ald. William Thompson.

Ald. Thompson, who has been chairman of the Electricity Committee since 1898, is no less than 86 years of age, and has been connected with the municipal government of the city for 40 years. He was presented with a silver trowel by Sir Charles Ellis, on behalf of the English Electric Company, who are the chief contractors of the new scheme. In the course of a speech on the site, Ald. Thompson mentioned that it was 30 years since Blackburn secured a provisional order for the supply of electricity, and 22 years since a separate Electricity Committee had been formed.

The New Station.

The new station will become the principal electricity station in Blackburn, the present station in Jubilee-street being used as a substation and distributing centre owing to the difficulties of coal transport and of getting sufficient water.

The question of a new station was first considered in 1912, plans and details being submitted to the Local Government Board in 1914, but the matter was shelved owing to the war, and it is only just recently that work has been allowed to proceed. The site at Whitebirk is approximately 64 acres in extent. Railway siding accommodation is available, and the Leeds and Liverpool Canal runs quite close so that coal can be either delivered by rail or barge.

Peat on the Site and the Use of Ashes.

It is interesting to note that 1,700 tons of peat have been removed from the part of the ground where the station is to be built, and there is a great deal more of this fuel available, which it is intended to turn to the financial advantage of the municipality. The part of the site which is not required for the station and its extensions will be let off as factory sites.

It will be possible to tip the ashes from the generating station on to a part of the land for many years to come. This will not only be a convenient arrangement, but will tend to improve the value of tho site. The conditions present have made it necessary for the foundations to be built on a reinforced concrete raft.

Generating Plant.

Arrangements are being made to instal two 10,000 kw. three-phase turbo-alternators, generating current at 6,600 volts and a frequency of 50. About half of this power is already earmarked for intending customers. The whole of the work in connection with the building as well as the supply of turbo-generators and the three rotary converters is being carried out by the English Electric Company.

For coal handling there will be a travelling crane, a 3-ton grab for unloading purposes and facilities for lifting trucks bodily and delivering their contents into a hopper on the ground level. A 1-ton skip hoist and conveyor will carry the coal to the storage bunkers, whence it will fall by gravity to the furnace grates. Arrangements for automatically weighing and checking the coal are also to be provided.

There will be seven boilers in all, three to each turbo set and one spare. These will be of the B. & W. type, each having an evaporative capacity of 50,000 lb. per hour, while in connection with them a B. & W. system of induced and forced draught will be installed, together with Green's economisers. Underfeed stokers of the latest type will be employed, and there will be four steel chimneys. The condensing plant will be supplied by Hick, Hargreaves & Weir, and there will be four double cooling towers, each capable of dealing with 1,400 gallons per hour supplied by the Film Cooling Towers, Ltd. To ensure the necessary water supply it has been decided to sink two artesian wells. The new and existing stations will be connected by trunk mains, and it is also intended to link up with the Preston supply in the near future.

The new station and plant has been designed throughout by Mr. P. P. Wheelwright, borough electrical engineer, to whom we are indebted for much of the information given in the above paragraphs. It is interesting to note that the whole scheme is being energetically pushed forward with the intention of giving a supply from the new plant during the forthcoming winter.

At a luncheon held after the ceremony Mr. J. Stanworth proposed the toast of the "Blackburn Electricity Undertaking."

The Mayor of Blackburn (Ald. L. Cotton), in reply, said that the extensions of the use of electrical energy made possible by the new station would help them to get rid of the smoke nuisance. At present they had applications for 7,000 kw. of new connections, and they were already preparing for extensions to the new station.

Mr. W. L. Hichens (English Electric Company), proposing the toast of North-East Lancashire, said our commercial prosperity had been built up by the ability of the inhabitants. He believed that our industrial prosperity was more due to the capacity of the workers themselves than to that of the employers. We had the ablest and most intelligent workers in the world.

Ald. R. Hargreaves, Mayor of Burnley, in reply, said they were looking forward to a cheap and abundant supply of electricity based on centralisation, co-ordination of supply and the delimitation of economic areas.

Coal in pulverised form has not yet made its appearance to any extent in Europe, whereas our readers are aware that this method of applying coal as a fuel has been widely adopted in America, chiefly by the iron and steel industries and for cement kiln firing. A certain number of boiler plants have been operated in this manner for some years, and it will be of interest to engineers in England to hear that the new 40,000 kw. generating station of the Milwaukee Electric Traction and Light Company have decided, after the thorough testing of pulverised coal firing at their existing station, to equip the boilers at the new works with pulverised coal apparatus. The contract for this work has been obtained by the Fuller Engineering Company, who will equip the station with their "Safety First" system; pulverised coal bunkers to carry a reserve of fuel will be erected at the boilers, the powdered coal being mixed with air for combustion at the actual burners.

According to the Board of Trade "Journal," the Calcium Cyanamide Factory of the Stickstoff Treuhand Gesellschaft, at Chorzow, near Beutzen, Germany, covers about 135 acres and employs 2,500 hands. There is a central power station of 20.000 kw. and another of 10,000 kw. is being constructed as a reserve while 30,000 kw. is supplied by the Schlesische Elektrizitats und Gaswerke. Calcium cyanamide is produced in seven electric furnaces, two being in reserve. The negative electrode is an earth, and the positive electrode consists of six blocks of graphite, size 1·50 metres by 0·50 metres by 0·50 metres. The electrodes are manufactured by the Siemens Schuckert Company and the Plana Company. For the production of calcium carbide the Linde process is employed, while the Caro method is used in preparing the cyanamide. One ton of chalk is used for every 950 kg. of calcium carbide, and 1 ton of calcium carbide is used for every 1,250 kg. of calcium cynanamide produced. The consumption of coal is about twice to three times the production of calcium cyanamide. The yearly production of cyanamide is approximately 125,000 tons.

Electrical Equipment of a South Wales Colliery.

The Berthlwyd Colliery, Gowerton, can justly claim to have one of the most up-to-date and efficient electrical installations that is to be found in the South Wales Coal district, though the electrical drive has been in use in one form or another for a great many years.

The original generating plant consisted of a 300 kw. alternator driven by a slow speed triple expansion steam engine. This was supplemented some few years later by a second alternator driven by a high speed compound steam engine. The two alternators were designed to run in parallel. The power from these two sets was used for driving certain machinery in and about the colliery, and gave such satisfaction that a short time ago it was decided to electrify the colliery generally, and for the sake of economy and efficiency of working to re-model the existing power house. To this end a contract was placed with the General Electric Company, Ltd., for the supply and erection of a 1,000 kw. turbo-alternator together with the necessary condensing plant and spray cooler, also for a modern high tension G.E.C. switchboard and electric haulage, &c.

A general view of the power house will be seen upon reference to Fig 1, which shows the new 1,000 kw. turbo-driven G.E.C. alternator in the foreground. This turbine runs at a speed of 3,000 revolutions per minute, and is directly connected to a 1,000 kw., 3,000 volt, three-phase, 50 cycle G.E.C. turbo-alternator. The power factor is 0·8 and the overload capacity of the alternator 25 per cent. for two hours without undue heating. Great care has been taken with the winding of the stator. The insulating tubes for the conductors are of micanite and moulded on to the coil itself, the complete coil with the insulation being pushed through the slots from one end. For this purpose one end of the coil is left straight. Heavy metal clamps with spacing blocks are arranged all round the windings to prevent any movement of the conductors or of the projecting ends of the coils under the stress imposed upon them when the machine is switched in or out of circuit, or in the event of a short circuit occurring on the distributing system. The rotor is constructed from one solid forging; this scheme having been adopted as a solid forging gives the strongest possible mechanical construction and allows of the running speed being as far below the critical speed as possible. The rotor winding is comprised of coils which are completely shaped before they are embedded in slots milled out of the solid drum.

The turbine is of the usual impulse type and is of most compact design, as will be seen by reference to Fig. 1. The exhaust steam is dealt with by a Cole Marchent & Morley's condenser, the end of this also being shown in Fig. 1. The circulating and air pumps, each driven by a "Witton" motor, the circulating pump motor (Fig. 2) being a 3,000 volt, 50 cycle, three-phase 55 B.H.P. slip-ring machine.

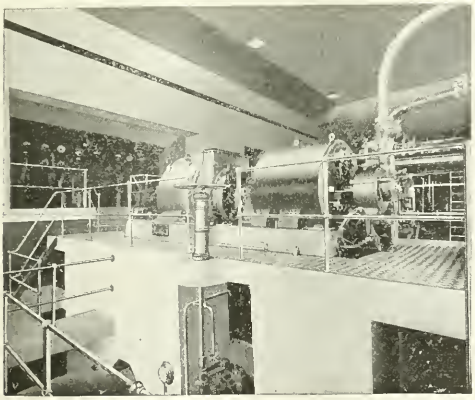

FIG. 1.—1,000 KW. TURBINE-DRIVEN G.E.C ALTERNATOR, SHOWING ALSO THE TURBINE AND PART OF THE CONDENSER.

The air for ventilating the alternator is passed through a Heenan & Froude wet air filter driven by a "Witton" motor, the system of ventilation being the usual G.E.C. system in which no air that is used to cool the rotor is used to cool any part of the stator. The two streams of air are kept quite separate, and as a result a very low even temperature rise in every part of the machine is obtained.

The high-tension G.E.C. mistake-proof switch-board is of handsome appearance, and consists of ten steel boiler plate cubicles. It controls the 1,000 kw. turbo-alternator as well as the two 300 kw. alternators, four high-tension feeders, and the auxiliaries. A voltage regulator is provided, the main and exciter fields of the three alternators being controlled through pillars.

The turbo-alternator set was put into operation in February, 1919, and, as has already been stated, runs in parallel with the older reciprocating engine driven alternators. Some interesting figures as regards coal consumption are obtainable. Up to the time the turbo-alternator was put into use, the colliery used for electrical purposes an average of 143 tons of coal per week. Immediately the turbo-alternator was installed this consumption dropped to 127 tons per week, and it was consequently found that one boiler could be dispensed with. The consumption then dropped to 112 tons per week. Unfortunately, due to economiser troubles, this consumption increased again to an average of 125 tons per week, but the fact remains that the new plant meant a saving of 31 tons of coal per week. The above figures are ordinary running figures, and were not obtained from runs which were even remotely in the nature of test runs.

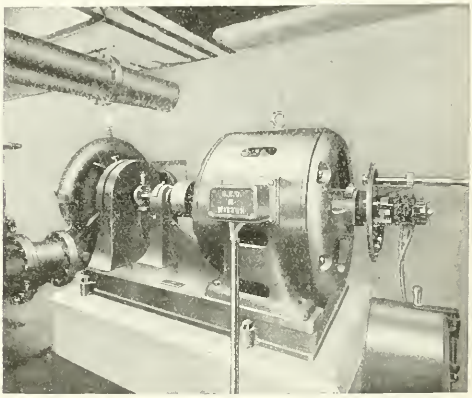

FIG. 2. CONDENSER WATER CIRCULATING PUMP DRIVEN BY A G.E.C. "WITTON" MOTOR.

Current is supplied to the underground workings at 3,000 volts, and is taken direct to the three-phase motors at that pressure for haulage and other purposes.

The cables connecting the power house to the underground workings and also to the Caereithin Colliery were also supplied by the General Electric Company, Ltd. They were manufactured at the Pirelli General Cable Works, Southampton, and are P.G. standard colliery cables manufactured to B.E.S.C. specification, consisting of circular section conductors, paper-insulated and lead-covered with B.O.T. earth shield, jute served, double galvanised iron wire armoured and jute served over all. They work with an unearthed neutral and are connected with a static detector to indicate the condition of the circuit.

The whole of the electrification described above was carried out by the General Electric Company, Ltd., who were main contractors for the complete equipment, from the designs and specifications of Mr. A. W. Blake, M.I.E.E., M.I.Mech.E., the consulting engineer. We are indebted to Mr. D. D. Williams (a joint proprietor of the Colliery) for permission to take the photographs.

Electric Power for Mines.

The Government Committee presided over by Sir Richard Redmayne, K.C.B., has taken much evidence as to the future of the South Staffordshire coalfield, the flooding of mines, &c. Several mining and electrical engineers and colliery owners favoured electric pumping for unwatering the mines, and suggested the erection of a central power station for supplying energy.

Mr. S. T. Allen, M.I.E.E., borough electrical engineer, Wolverhampton, said a scheme had been considered for supplying electricity for Staffordshire and Shropshire by means of joint working, which included the erection of a new power station having a capacity of about 230,000 kw. The estimated requirements of what was known as the Black Country in the future were about 150,000 kw. For large power stations the water supplies should be regular and permanent. The only mines water that would be considered was that due to continuous drainage, which could be maintained in constant volume, with no possibility of diminution or cessation. Mines drainage water could be used provided it did not contain an excess of corrosive or scale-forming compounds in solution. For a station of 100,000 kw. capacity the amount of water required for direct circulation, if such a load were maintained, would be 200,000,000 gallons per day. He understood that there were 12½ million gallons available in the Tipton district, but he did not know whether that amount of water would be available at one point. The amount would be sufficient for a plant of about 6,000 kw. He did not think the supply of water, if it lasted 20 years, would warrant the erection of a special power station, but he said the amount of water available would not be one-tenth of the requirements of the new scheme to which he had referred. The scheme, which would serve an area of about 2,500 sq. miles, had been provisionally agreed upon at a conference of authorities, and the Electrical Commissioners would consider the matter shortly. If coal came to a normal figure of 15s. per ton, they would be able to supply power at ½d. per unit, and, if pumping was resumed, they would be able to supply power as cheap as anywhere.

Mr. G. R. J. Parkinson, chief engineer to the Midland Electric Corporation for Power Distribution, said his company used at their Ocker Hill generating station about 80,000 tons of slack per annum. That slack was at present drawn chiefly from the Old Hill, Oldbury, Kingswinford and Walsall Wood districts. In the event of the Tipton mines being reopened a large quantity of slack would be drawn close to the generating station, and a considerable saving in transport effected. There was a large and growing demand for electric power in the Black Country. The generating station was fully loaded, and, although they had room for extending at Ocker Hill, they were faced with the difficulty that there was not sufficient cooling water available for dealing with any large extension of plant. In view of the difficulty of obtaining water, which was shared by other electric supply undertakings in the district, at the instigation of the Electricity Commissioners, the electricity authorities in South Staffordshire had been considering the advisability of building a large joint generating station either on the Severn or the Trent. Although it might be necessary eventually to adopt such a course, owing to the high cost of transmission lines and the losses involved in transmitting a large amount of power such a long distance, it was advisable to defer that proposal as long as possible. If sufficient cooling water could be obtained at a reasonable cost to operate a generating station of, say, 20,000 kw. capacity, the larger scheme could be put off for a number of years. A generating station of 20,000 kw. capacity, if supplied with cold water without cooling towers would require about 1,800,000 gallons of water per hour. By the utilisation of cooling towers the same station could be operated with a fresh supply of cold water of about 450,000 gallons per hour. If, therefore, it was found practicable to pump continuously large quantities of cold water from the mines, and supply that at a suitable spot for a generating station, the water could be utilised for condensing purposes. The feasibility of such a scheme depended upon the maintenance of a continuous supply of water at one point, guaranteed for at least 15 years, and on a low rental. The limit of the capacity of the Ocker Hill plant had been reached. The company had on order plant of an additional 5,000 kw., and they were coupling up their mains with the Wolverhampton station, whereby a further 4,000 kw. would be available.

Legal Intelligence.

The Business Names Act.

In the Shoreditch County Court on Tuesday, the Electrical Repair & Mfg. Company sued Hettie Anders (as administratrix of the estate of Nat Anders) to recover £7 12s. 6d. The firm not having been registered under the Business Names Act, Judge Cluer said he could not hear the case, as a firm could not sue under a contract unless they were registered under the Act. After some discussion, the case was dismissed.

Increased Charge for Electric Supply.

At Carmarthen County Court last week, Judge Morgan decided that the local Electric Light Company could not recover an increased charge for electrical energy allowed under the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, until the Corporation had given their consent to the increased charge. It appeared that on Sept. 29, 1919, the Board of Trade made an Order authorising the company to charge a sum not exceeding 9d. per unit. On Oct. 27 the company gave notice to consumers that the price would be increased from 7d. to 9d. as from the date of the Order, and on the same day the company applied to the Corporation for consent to the increased charge. Consent was not, however, given until Jan. 8 last. The judge held that the resolution passed by the Corporation on Jan. 8, giving the company permission to charge the increased rate had no retroactive effect so far as private supply was concerned. It is proposed to appeal against the decision.

Dinner to Mr. F. Ayton.

On Monday last at Frascati's, London, Mr. W. H. L. Watson, of Edison Accumulators, Ltd., presided over a gathering of 70 battery vehicle makers, who were met to do honour to Mr. Frank Ayton, M.I.E.E., borough electrical engineer of Ipswich and the Chairman and Honorary Secretary of Electrical Vehicle Association of Great Britain. The presentation of a silver bowl and a handsome cheque was made by Mr. Watson to Mr. Ayton, who, in acknowledging the gift, spoke hopefully of the future of battery traction in this country. The gathering was fully representative of this branch of the industry, and the toast list included the names of Major Whittington, Mr. E. S. Shrapnell-Smith, C.B.E., Vice-Chairman of the Electric Vehicle Committee, Mr. A. S. Mays-Smith, Hon. Treasurer of the Society of Motor Manufacturers and Traders, Mr. E. C. Ransome, of Messrs. Ransomes, Sims & Jefferies, Mr. E. W. Curtis, Managing Director of the General Vehicle Company, Mr. J. P. Kemp and Mr. J. W. Beauchamp. After the toasts an excellent musical programme, arranged by Mr. S. G. Trehearne, of Edison Accumulators, was performed.

Commercial Topics.

Overseas Trade Development.

The Department of Overseas Trade have recently appointed additional members of the Advisory Committee of the department. The Committee now consists of 19 members, and it is satisfactory to learn that one-third of the number are prominently associated with the important engineering and metal industries. Among those on the revised Committee are: Sir Francis H. Barker (director, Vickers Limited); Sir John Dewrance, M.Inst.C.E. (chairman, Babcock & Wilcox, Ltd.); Sir William Ellis (director, John Brown & Company, Ltd.); Sir Algernon Firth, Bart. (chairman, T. F. Firth & Sons, Ltd.); Mr. W. L. Hichens (chairman, Cammell, Laird & Company); Mr. Walter Leaf (chairman, London County, Westminster & Parr's Bank, and of St. James' & Pall Mall & Central Electric Supply Companies); Sir William Pearce, M.P. (director, Spencer Chapman & Messel, Ltd., chemical manufacturers); Sir H. Babington Smith (director, British Trade Corporation and Italian Trade Corporation).

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Operation of the Business Names Act.

Although there have been some prosecutions for failure to comply with the terms of the Business Names Act of 1916, it would appear that the scope and effect of the Act are not yet known to or appreciated by many. At the Shoreditch County Court last week, an action for the recovery of a debt by a company which had not been registered was dismissed, as the judge held that he could not hear the case until the company had complied with the obligation of registering. It must be clearly understood that every firm carrying on business under a business name which does not consist of the true surnames of all partners, and every individual carrying on business under a business name, must be registered. Failure to do so means that the firm or trader cannot sue or recover a debt, even if justly contracted, unless the judge finds that the default is accidental or due to inadvertence or some other sufficient cause. In the case in question the judge refused to grant relief, so that the company will have to commence a fresh action after the registration has been duly effected.

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Germano-Japanese Trade.

Serious efforts are now being made to develop trading between Germany and Japan, and to bring about an interchange of inventions, &c. Among these may be noted the formation of an important company, entitled the Tairiku Bocki Kabushiki Kaisha (Continental Trading Company, Ltd.), with headquarters at Tokio, and a branch office at Osaka, to open up commercial relations between the two countries. The capital is 10,000,000 yen in shares of 50 yen, of which 180,000 will be taken up by the promoters and supporters, who number (according to the "Board of Trade Journal") over 1,000 professors and well-known business men. Among the objects of the company are:—(1) Importation from Germany and other countries of chemicals, medical and surgical appliances, industrial products, high-class machinery, microscopes, glasses, literary publications and general merchandise; (2) Manufacture and sale of chemical and industrial products and machinery, &c.; (3) Export of raw materials and manufacture; (4) Capitalising and encouraging enterprises on the above lines in Germany and Japan. The company will have the co-operation of Herr Bart of Bremen, and Herr Werner, of Saxony, who have had long experience of Far Eastern affairs. Selected Japanese industrialists, engineers and chemists have been sent to Germany to study conditions. It is also claimed that the cheap labour of Japan and raw materials of the Far East will be additional advantages for the furtherance of the scheme to reap the benefits of the many German war-time inventions and discoveries.

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Canadian Electrical Manufacturing Industry.

A preliminary report on the Canadian electrical apparatus industry for 1918 has been issued, and though the figures are interesting considerable progress has been made during the last 18 months owing to the increasing demand for hydro-electric generating plant, for motors and electric light fittings. The statistics relate to 68 manufacturing plants, of which 42 are in Ontario, 13 in Quebec and 7 in Manitoba. The total capital invested is $43,285,405, and the number employed is 8,863 (including 2,268 females). The following are the figures of the output of products, quantities (stated in brackets where given) and the selling price at works:—

Dynamos, generators and converters (14,249), $1,503,443; transformers (193,904), $2,291,874; switchboards, switch panels, &c., $990,898; motors (115,111), $2,727,673; storage batteries (262,514), $212,624; primary batteries (4,869,468), $1,397,635; incandescent lamps (601,288), $1,525,198; incandescent lamps (No. not specified), $399,547; sockets, bases, &c., $415,855; electric light fixtures, $311,844; telegraph apparatus, $71,230; telephone transmitters (26,175), $50,000; telephone receivers (56,750), $95,000; telephone interior systems (46,478), $444,000; telephone central switchboards (37), $750,000; telephone private exchange boards (323), $110,000; insulated wires and cables, $5,154,984; electrical machinery (other), $1,738,085; carbons, $1,362,666; and other miscellaneous products, $8,492,843. The total selling value of the whole of the products was $30,045,399.

The system of classification and grouping adopted is not satisfactory or sufficiently detailed. Moreover, the census only covers the more important factories in the industrial parts of the Dominion; but, nevertheless, the figures indicate a steady development in the direction of the production of articles which were formerly imported from Canada.

Electricity Supply.

Extensions of the FAVERSHAM Corporation electricity works are to be carried out at a cost of about £15,000.

LANARK Corporation has authorised the special Electricity Committee to engage an electrical engineer to prepare a report on the question of electricity supply.

The Electricity Commissioners have authorised the SHOREDITCH (London) Borough Council to extend the Whiston-street power station at an estimated cost of £118,495.

The GREENLAW (Berwick) Council is anxious to have authority to introduce electric supply and application is to be made to the Electricity Commissioners for a special order.

HAMILTON Corporation has authorised Edmundson's Electricity Corporation to expend £5,250 on the purchase of a 500 kw. rotary converter for the local electric supply works.

The demand for electric current for mills and workshops is increasing so rapidly at BURNLEY that the Council have been recommended to seek borrowing powers for £150,000 to provide extra generating plant.

COLERAINE Urban Council have declined to permit a private company to erect electricity supply works, and a consulting electrical engineer is to be employed to outline a scheme for electricity supply.

The London County Council has sanctioned loans of £11,500 to HACKNEY Borough Council for motor converters and of £11,860 to Hammersmith Borough Council for linking up its undertaking with those of Battersea and Fulham.

BLACKPOOL Electricity Committee have decided to install additional boilers at the Electricity Works, and the borough engineer and manager (Mr. C. Furness) has been instructed to place before the Electricity Commissioners the local position in regard to electricity generation and distribution, and to ascertain their proposals for the future development of electricity supply on the West Coast.

TURTON Urban Council contemplate taking electricity in bulk from Bolton, and a provisional scheme provides for four distinct areas—Bradshaw, Egerton, Horrobin and Edgworth: each area, whilst complete in itself, will be linked up with the other districts. A sub-station will be erected at Bradshaw, and sanction is being sought for a loan of £20,000 for its equipment and for laying mains.

At a representative meeting of CULLOMPTON (Devon) ratepayers last week a resolution in favour of erecting electricity works was adopted, and a committee was appointed to raise £10,000 for the scheme. The Rev. J. W. Bishop, who is a member of the committee, is a strong advocate of electric lighting, and thinks that there would be a demand for private lighting of about 2,250 25-c.p. lamps.

KENDAL Town Council is considering a scheme of electric supply extensions, estimated to cost £8,000 to £10,000. Major Milnes, of Lancaster, has been requested to report on the development of the undertaking. Last winter consumers were asked to limit their consumption because of the shortage of plant, and next winter the demand will be double, so extensions are urgently needed.

As from June 24 the following increased charges for electrical energy will apply in CHESTER: Lighting, flat rate of 5¼d. per unit; small power consumer, first 1,000 units per quarter, 2·5d.; second 1,000 units, 2·25d.; third 1,000 units, 2d.; fourth 1,000 units, 1·75d.; any further quantity, 1·5d. Large consumers, £6 per kilowatt demand, plus 0·75d. per unit; domestic supply 15 per cent. on rateable value plus 1d. per unit.

In order to provide for next winter's demand HAMPSTEAD (London) Borough Council proposes to take a bulk supply from Marylebone Council. The cost of linking up, converting plant, &c., will be £35,684. It is proposed to take 1,500 kw. at the outset, and the cost per unit based on the charge to be made by Marylebone is as follows:—Capital charges on £35,684 (at 15 years), £3,450; 1,500 kw. at £3 per kw. plus 0·88d. per unit £10,000, allowance for transformer losses, £100, a total of £13,550, equivalent to 2·161d. per unit during the period of repayment of the loan, and 1·616d. per unit after its expiration, compared with the present generation cost of 1·800d.

HORNSEY Corporation has applied for sanction to borrow £10,220 for completing the Muswell Hill sub-station and £2,500 for the installation of automatic stokers to two boilers. The borough electrical engineer (Mr. N. Staniland) has been instructed to interview the Electricity Commissioners on the subject, and on the future of the undertaking. The Council is of opinion that to take a supply of electricity in bulk would be extremely detrimental to the undertaking, as well as being financially unsound. In order to cope with the requirements of the borough until 1925 and beyond a further capital expenditure of £41,000 to £43,000, spread over the next two or three years, may be necessary.

The Corporation of SOUTH SHIELDS has adopted a recommendation of the Electrical Committee to train youths in electrical works so as to be able to replace employees when they leave, are ill, or off work through other causes. The boys will receive nothing for the first six months but afterwards they will get 10s. per week, rising to £2 in the fourth year. The Committee also proposed to train demobilised men, and Ald. Henderson said the Government would give every assistance.

Ald. Dunlop, who moved that the scheme be referred back to the Committee, did not object to the boys, but with regard to ex-officers there was a design on the part of the Government to have men placed in electricity and gasworks, on tramways and other concerns so that they could take the place of men who went on strike. Ultimately that portion of the report referring to the ex-officers was referred back, the recommendation concerning the boys being agreed to.

Electric Traction.

Nine new electric tramcars are to be purchased by MIDDLESBROUGH Corporation at £3,420 each.

NELSON Council has applied to borrow £36,000 for the erection of a new car-shed, workshops, machinery and equipment for the tramways.

The new Gravelly Hill route of the BIRMINGHAM Corporation tramways, which is two miles in length, has been officially inspected and passed for traffic.

The SOUTH SHIELDS CORPORATION LIGHT RAILWAY ORDER has been submitted to the Minister of Transport for confirmation. Any objections must be sent to the Minister of Transport (Public Safety and General Purposes Department), Whitehall-gardens, S.W.1, by May 27.

The Bill authorising ST. ANNES-ON-SEA URBAN COUNCIL to purchase the Blackpool, St. Annes and Lytham Tramways Company, Ltd., for £135,000 has passed the House of Lords as an unopposed measure. St. Annes is to pay Lytham 25 per cent. of the net profits earned in Lytham until Lytham Council purchase their portion of the undertaking.

PLYMOUTH Corporation has authorised an increase of fares on the tramways. It was explained by the chairman of the Tramways Committee (Mr. J. Hayne Pillar) that the 1d. fares were impracticable as the cost per car-mile was 1s. 8d. and the receipts were only 1s. 7d. The present rates would mean a loss of £4,000 per month, or an 8d. rate.

The first of six enclosed bogie tramcars, which are being converted at the SUNDERLAND tram sheds, has been put into service. A new truck is used, which ensures smoother running; the motors are each of 30 h.p., and there are front exit gates. On the upper deck, which is of the saloon pattern, there are seats for 40.

Those tramway undertakings which are contemplating the use of motor omnibuses as a substitute for tramways will be interested to learn that HALIFAX Tramways Committee has decided to discontinue the motor 'bus service recently established between Mytholmroyd and Cragg Vale. It is stated that even with a subsidy the 'buses are being run at a loss.

The District Council for the Tramway INDUSTRY for YORKSHIRE, LINCOLNSHIRE and NORTH DERBYSHIRE have made the following recommendations:—The area is to be divided into four groups, viz., Huddersfield, Bradford and Hull, the increase in employees' wages to be, 1d. per hour on the basic rate; Sheffield and Leeds, ½d. per hour; Halifax, Doncaster, Chesterfield, Lincoln, York and Barnsley, ¼d. per hour; and Wakefield, Yorkshire woollen district, Keighley, Rotherham, Mexboro', Dewsbury, Ossett and Grimsby, no advance recommended.

In connection with the provision of new rolling stock for the LONDON COUNTY COUNCIL tramways service it has been decided to institute a competition for designs for new electric tramcars and to offer a prize of £1,000 for the most satisfactory design. The Highways Committee report that, in order to meet the increase in traffic it will be necessary to increase the rolling stock by 204 tramcars, of which 79 will be available from the existing stock, when certain repairs are effected, and tenders are to be invited for 125 new cars.

The Council has increased the rate of pay of wiremen and wiremen's mates in the depot wiring section of the electrical branch of the tramways department from 2s. to 2s. 3d. and from 1s. 7d. to 1s. 9d. an hour respectively.

Telegraph and Telephone Notes.

An INDIAN WIRELESS TELEGRAPH BOARD has been constituted as follows: Director-General of Posts and Telegraphs (president), the Chief Engineer of Telegraphs (vice-president), the Director of Wireless Telegraphy, the Chief Signal Officer at Army Headquarters, an officer of the Military Operations Directorate, an officer of the Royal Air Force, and an officer nominated by the Commander-in-Chief of H.M. Ships and Vessels in the East Indies.

Experiments in the use of WIRELESS TELEPHONY for FIRE CALLS have been carried out by Marconi Wireless Telegraph Company at Putney Common, which is about seven miles from the fire brigade headquarters in Southwark Bridge-road. A fire tender lent by the brigade, was fitted with a standard Marconi aircraft transmitter and receiver, and similar apparatus was placed on a small table in the chief officer's room at headquarters. In the test communication was obtained between the tender and headquarters in 60 seconds. The Marconi operator hooked his apparatus to a tree, answered his call, and received a reply. On the return journey, the tender was stopped in a public thoroughfare, the Marconi apparatus wire was hooked to a lamp-post, and communication was established just as readily as before.

Particulars of the progress made with the laying of MAIN UNDERGROUND TELEPHONE LINES were given by Mr. Pike Pease in an answer to a question in the House of Commons on Monday. The London-Manchester line was begun in July last, and the Liverpool-Manchester line in October last. The construction of an underground cable from Hull to Grimsby will be begun as soon as materials are available. Provision is proposed in the current year's programme for a further cable on the London-Manchester route as far as Derby, and thence to Leeds, Newcastle and Scotland, also for a new underground cable between Manchester and Huddersfield. Wires in these main cables will be linked up with spare wires in the existing cable between Hull and Leeds to form circuits from Hull to London, Newcastle, Manchester and Liverpool. When the new routes have been completed it will probably be possible to provide direct circuits from Hull to several other towns in Lancashire and Yorkshire, and the trunk service to the Midlands and Scotland will be considerably improved.

Imperial and Foreign Notes.

It is proposed to establish municipal electricity works at Singleton (N.S.W.).

Warnambool (Victoria) Council is considering a scheme for electricity supply estimated to cost £30,000.

The Adelaide Electric Supply Company has entered into a contract to supply electrical energy in Kensington and Norwood (S. Australia).

Toowamba (Queensland) Council, which has decided to construct electric tramways, is negotiating for the acquisition of the local Electric Light and Power Company's undertaking.

The Madras Government has approved of the construction of a Telephone Line from Madras to Ootacamund by the Indian Government Telegraph Department.

The Empire Steel Corporation was recently incorporated in Canada with a capital of $500,000,000 for combining and controlling various Canadian steel, coal and other interests. The company will be controlled from London and the directors include: Lieut.-Col. W. Grant Morden, M.P., Lord Furness, Sir William Beardmore, Sir Newton Moore, Mr. H. Steel and Mr. B. Talbot.

Specifications are being prepared for the plant required by the Victorian Electricity Commissioners in connection with the generation of power from the brown coal at Marwell. The Commissioners expect the supply of power to be available in three years. The preliminary investigations in regard to the Kiewa river power scheme have now been completed.

A preliminary survey of the Waterfalls in Brazil has been made by the Brazilian Institute of Engineers. There are, it is stated, 148 waterfalls which could supply energy of 30,000,000 h.p.

The duties upon imports of the following articles into Finland have been increased for the year 1920 by 200 per cent.: Electric machines weighing not more than 500 kilogs. each (upon which the former duty was equal to 19s. 3d. per cwt.); tramway vehicles (formerly £32 each); special apparatus for electro-technical purposes not specially mentioned in tariff, steam engines, steam and water turbines, and explosion motors.

The Berlin Osram Lamp Company has intimated to buyers in the former Austro-Hungarian Empire that it considers itself no longer bound by the international convention concerning incandescent lamps in Austria and Hungary. In conjunction with American and British capitalists the firm proposes to erect a factory near Prague, which will supply Czecho-Slovakia and the newly created States and the Balkan Peninsula. According to the old convention the factories of Vienna were safeguarded against German, Dutch and Swiss competition.

Personal and Appointments.

The Senate of Cambridge University will confer the degree of D.Sc. upon Sir Joseph Thomson and Sir Joseph Larmor.

Prof. J. Wemyss Anderson has been appointed to the recently established Hughes Chair of Refrigeration at Liverpool University.

The Council of the Sheffield University has invited Prof. Ripper to continue as professor of engineering for a further term of two years.

Mr. F. E. Smith, C.B.E., F.R.S., of the National Physical Laboratory, has been appointed director of scientific research to the Admiralty.

Miss Gertrude L. Entwistle is the first lady to be elected to the Associate membership of the Institution of Electrical Engineers.

Mr. C. Nicolson, assistant electrical engineer at Weymouth, has been promoted to borough electrical engineer, at £500 per annum.

Mr. E. S. Barralet, manager of the insulating varnish department of Messrs. Pinchin, Johnson & Company, Ltd., has been elected a director of the Company.

Mr. A. B. Muirhead, who has been associated with Messrs. D. Selby Bigge & Company, consulting engineers, has become a partner in the firm.

Sir Jagadis C. Bose, who was admitted to the fellowship of the Royal Society on the 13th inst., is the first Indian to attain this distinction for scientific work.

The Penzance staff of the Western Union Cable Company have presented a gold watch to Mr. E. Townsend, who is being transferred to the New York staff of the company.

Accrington General Purposes Committee propose that the salaries of the electrical engineer (Mr. A. W. Clegg) and tramways manager (Mr. H. Pilling) be increased, in lieu of war bonus, from £500 to £650 per year as from April 1 last, with a further addition of £50 next April.

Mr. Richard Hoggard, of Sheffield, who has been appointed traffic superintendent of the Wigan tramways, has been presented with an illuminated address, a china display cabinet and photographs of himself and Mrs. Hoggard.

At the investiture held in Newcastle by Prince Henry on the 7th inst., Capt. L. E. Mold, of Messrs. A. Reyrolle & Company, Hebburn-on-Tyne, was decorated with the O.B.E. (Military Division) for services in France. Mr. Mold joined up in August, 1914, as a private with other members of the firm.

Mr. Ernest Morgan, A.M.Inst.C.E., A.M.I.E.E., who for the past ten years has served with the Yorkshire Electric Power Company (latterly as operation engineer), has been appointed technical and engineering assistant to the chief engineer and general manager of the Wolverhampton Corporation electricity undertaking.

Mr. C. C. Valder has been appointed Supplies Manager of the Sheffield branch of Messrs. Siemens Brothers & Company, Ltd., at 23, Filey-street, Sheffield. He has been employed with the firm since 1910, originally in the fittings department, and since demobilisation in the estimating department of the lamp and supplies department, Upper Thames-street, E.C. He served with H.M. Forces throughout the War. In 1914 he was a sapper in the London Electrical Engineers, after which he was gazetted 2nd Lieut. in the King's Own Royal Lancashire Regiment. Later he became Captain in charge of divisional Artillery Signals, and was eventually temporarily in command of the 66th Division Signal Company of the Royal Engineers from July, 1915, to June, 1919. While in this position he was awarded the M.C. for meritorious service at Landrecies.

Institution Notes.

The Electrical Trades Benevolent Institution have formed an Advisory Committee at South Shields. Mr. W. C. Mountain is chairman; Mr. T. W. Anna, hon. secretary; and Mr. J. Gledson, hon. treasurer.

The Chemical Society has recently secured a supplemental charter and revised its constitution. Fellows may now be of either sex, and in future the Council and officers may be elected by a postal vote. The new by-laws come into force on June 1.

The Institute of Metals will hold their annual autumn meeting at Barrow-in-Furness on Sept. 15 and 16. The tenth annual May lecture will be delivered by Prof. C. A. F. Benedicks, of Stockholm, at the Institution of Mechanical Engineers, Storeys Gate, on June 10, the subject being "Recent Progress in Thermo-Electricity."

Members of the Scottish Centre of the Institution of Electrical Engineers will visit the power installation of the British Aluminium Company at Kinlochleven on June 11, 1920. This promises to be a most attractive three days' excursion, and will be particularly interesting at the present time, when the development of water-power in Scotland is receiving so much attention.

On Tuesday next Major C. E. Inglis begins a course of two lectures at the Royal Institution on the "Evolution of Large Bridge Construction," and on Saturday (May 29) Prof. J. H. Jeans commences a Course of two Lectures on "Recent Revolutions in Physical Science" (1) "The Theory of Relativity"; (2) "The Theory of Quanta." The Friday evening discourse on May 28 will be delivered by Prof. W. L. Bragg on "Crystal Structure."

At the recent meeting of the Yorkshire branch of the Association of Mining Electrical Engineers, held at Leeds the following officers were elected for the year 1920-21: President, Mr. J. W. Harbottle; vice-presidents, Mr. J. W. Mitchell and Mr. J. T. Lee; hon. sec. and treasurer, Mr. W. Winter (Castleford); auditor, Mr. H. Green; council, Messrs. R. Holiday, A. R. Chaytor, F. Mawson, A. Barker, M. W. Robinson, Major F. Mellor, J. R. Haigh, E. A. Moorhouse and T. Crossley.

At the meeting of the British Association, which will be held at Cardiff on Aug. 24-28, the president (Prof. W. A. Herdman) will deal in his address with oceanography. Among the presidents of sections are the following: A (Mathematics and Physics), Prof. A. S. Eddington; B (Chemistry), Mr. C. T. Heycock; F (Economics), Dr. J. H. Clapham, C.B.E.; G (Engineering), Prof. C. F. Jenkin, C.B.E.; L (Education), Sir Robert Blair.

Scientific Paper No. 371 of the Bureau of Standards, on "A New Cadmium Vapour Arc Lamp," states that a new method for producing a cadmium vapour arc of great brilliancy has been discovered. It was found that the metal gallium alloyed with cadmium. Since gallium has a boiling point above 1,500°C., the vapour pressure relation which exists between cadmium and mercury is reversed when compared with cadmium and gallium. The cadmium, therefore, acts as the energy carrier when used in combination with gallium in a quartz lamp.

On Saturday last members of the South Midland Centre of the Institution of Electrical Engineers paid a visit to Loughborough, where they inspected the Technical College and the works of the Brush Electrical Engineering Company. The journey was made by road. Great interest was taken in the equipment of the college, which is exceedingly up to date, so that the student has every facility for obtaining a good basic training, while every effort is made to carry out the training under the most practical conditions. At the Brush works the party spent a great deal of time inspecting the details of manufacture of the Ljungström turbine, while in the transformer department they had the opportunity of seeing some very large transformers in course of construction and the employment of high-tension Bakelite insulators for this class of work. Those attending this visit were entertained to lunch by the college authorities and to tea by the Brush Engineering Company.

The Committee of the Students' Section of the Institution of Electrical Engineers report that the activities of the section have greatly increased during the session, both on the business and social side. Ten general meetings and the annual general meeting were held at the various technical colleges in London. A joint meeting with the graduates Association of the Institution of Mechanical Engineers was also held. Visits have been paid to works, and an attempt is being made to revive the annual tour, which, it is hoped this year will take place in the neighbourhood of Glasgow. The Committee express their gratitude to the British Electrical and Allied Manufacturers' Association for their offer of prizes of the value of £10 each for papers by students suitable for publication in the Beama "Journal." The membership of the Students' Section has increased very considerably during the session, and this increase has been very helpful in ensuring success in the many activities of the section. Premiums have been awarded to Messrs. R. L. Smith-Rose, B.Sc. A. G. Everett, R. T. Fleming, R. Gates, E. A. Guthrie, A. G. Ramsey, C. E. Webb, E. T. Norris and J. Scott-Taggart for Papers read before the section.

Miscellaneous.

Liverpool electricians have applied for increased wages, from the present rate of 2s. 1¾d. per hour to 2s. 6d. Application has also been made to standardise the pay of apprentices, the advances asked for being 10s. a week to boys over 18 years of age and 5s. to boys under 18.

The Rotary Club of London has 14 committees engaged on the task of finding jobs for demobilised men. Engineering firms or manufacturers who experience difficulty in finding suitable labour can get help from the Engineering Committee. Particulars of vacant jobs should be sent to "Rotary Room," Horrox's Hotel, Norfolk-street, W.C.2. Club Committees are working in co-operation with the Appointments Dept.

The third and in many ways the best of the Mazda House Series of Staff Entertainments took place at Slaters' (Cannon-street) Restaurant in the 7th inst. The brilliancy of the Mazda lamp seemed to have its counterpart in the care-free vivacity of the staff, although the low current consumption of the former did not find any gastronomic parallel during the supper interval. At 6.30 p.m. the party of 100 sat down to progressive whist for upwards of 90 minutes, and the prizes were distributed by the chairman (Mr. F. Shaw) at supper Subsequently the company engaged in terpsichorean exercises, interspersed with songs delightfully rendered by members of the B.T.-H. staff.

The strike of electricians and wiremen who are members of the E.T.U. at the Port Sunlight Works has been settled, and a temporary agreement made between the Electrical Power Engineers Association (the employment of whose members was the cause of the strike) and the E.T.U. The terms of the agreement include the withdrawal of the circular of the E.P.E.A. of 24th Feb. last, and the question of the bona fides of the E.P.E.A. as a recognised trade union is to be dealt with temporarily by the Liverpool or Birkenhead Trades Council; alternatively that the members of the E.P.E.A. employed at Messrs. Lever Bros. act in conformity with the decisions of the E.T.U.'s Mersey District Committee pending a joint meeting of the two executives on the 28th inst.

An Inquest was held at Aberdare last week upon William John Priest, an electrician, who was recently killed at Bwllfa No. 3 Colliery. Deceased, who was engaged in disconnecting some temporary wires, was directed to proceed to the transformer house and the current was switched off. Shortly after an assistant electrician accidentally turned on the current at the distribution house and Priest received a shock which proved fatal. Artificial respiration was applied unsuccessfully. In finding that death was due to misadventure, the Coroner remarked that it was due to an error of judgment and of observation on the part of the assistant electrician.

The Coroner said that, in his opinion, the electric wires were not sufficiently protected, and the jury returned a verdict of "Accidental death," adding a rider that such wires should be protected, and that the matter should be brought before the proper authorities.

An inquest was also held at Newcastle-on-Tyne last week on Ralph Henderson, who died as the result of a fall from a crane at Close Works, Gateshead, on April 29. Evidence was given to show that deceased was sent to replace some bolts in the hoist motor of an overhead electric crane; he slipped on the girder, and tried to save himself by catching hold of the wires which supplied current to the cranes. The man in charge of the night shift admitted he knew the wires were live, and that he had no special knowledge of electricity. The wires were 4 ft. or 5 ft. above the crane platform.

Another case of a rat on the 'bus bars causing electrical breakdown occurred recently at Messrs. Alldays & Onions, Ltd., Matchless Works. As the chief electrician was switching in an explosion occurred, scorching his hand and arm. A thorough search disclosed that the connections on one side of the panels were burned out. An examination of the next panel showed the cause of the breakdown was a large rat, which had got across the 'bus bars. This venturesome animal had rendered the 'bus bars and contacts practically useless, six of the porcelain insulators being smashed and the whole coated with oil. We are glad to hear that Mr. Cossage, the electrician, is recovering from his accident, which for some time gave him considerable pain.

It is announced that on June 9 the King will open at the Crystal Palace the Imperial War Museum, to which is attached the Great Victory Exhibition, a dual enterprise which will tax even the capacity of the Palace, the largest exhibition building in the world. H.M. Office of Works have taken the whole of the main floor for naval, military and aircraft exhibits. An important and comprehensive section will be devoted to oil exhibits. There will be a number of working models, which will provide the most complete exhibition of the various branches and possibilities of the oil industry that has ever been assembled in one place. In addition, the sections comprising electricity, engineering and gas will have a commanding interest, and the public will have an opportunity of learning how knowledge gained in the science of war can be applied to the progressive achievements of peace.

The following firms have been recently elected members of the British Electrical and Allied Manufacturers' Association: Messrs. J. A. Crabtree & Company (Walsall), Crossley Brothers (Openshaw), Crypto Electrical Company (London), English Electric Company (London), Fielding & Platt (Gloucester), Heatly-Gresham Engineering Company (Letchworth), Keighley Gas Engine Company (Keighley), National Gas Engine Company (Ashton-under-Lyne), New Switchgear Construction Company (Sutton), C. H. Parsons, Ltd. (Birmingham), Parsons Motor Company (Southampton), Frank Pearn & Company (Manchester), Premier Gas Engine Company (Sandiacre), John Robson (Shipley), Ltd. (Shipley), W. H. Roy & Company (Manchester), Alex. Shanks & Son (London), and the Tok Mfg. Company (London).

Tenders Invited and Accepted.

London County Council require tenders by 4 p.m. June 7 for about 5,500 tons of steel tram rails, guard rails, fastenings, &c. Specification, &c., from the Engineer, County Hall, Spring Gardens, S.W.

Greenock Corporation require tenders by May 31 for the electric lighting work of 52 "flatted" houses at Cornhaddock. Specifications from the Town Clerk, Greenock.

Launceston (Tasmania) Corporation require tenders by 3 p.m. June 7 for one 1,000 k.v.a. Hydro-turbo-alternator, with Switchgear, &c. Specification from the City Electrical Engineer.

Trimdon Parish Council want tenders by May 25 for repairing the electric lighting distribution system in the villages of Trimdon Grange and Trimdon Colliery. Specifications from the Clerk, 24, South-view, Trimdon Grange.

Manchester Electricity Committee require tenders by June 4 for 12 months' cable supplies, fuse boxes, wood troughing, compound, transformers, &c. Forms of tender from Mr. F. E. Hughes, Town Hall, Manchester.

Rhondda Education Committee require tenders by noon, June 15, for wiring their Porth, Tonypandy and Pentre secondary schools (about 489 points). Specifications from Mr. J. M. Bowman, Electricity Works, Porth, Glam.

Fort William Corporation want tenders by May 31 for electric wiring in eight blocks of houses, being the first section of the Council's housing scheme. Schedules from Mr. J. G. Falconer, Architect, Cameron-square, Fort William.

The Tyne Improvement Commissioners require tenders by May 27, for six months' supply of incandescent lamps, arc lamp carbons, rubber and asbestos goods, &c. Forms of tender from the Manager, Berwick-street, Newcastle-on-Tyne.

Barnes Urban Council require tenders by noon, June 7, for coal handling plant and overhead steel or ferro-concrete bunkers. Specification from the Engineer and Manager, Electricity Works, High-street, Mortlake, London, S.W. 14.

Manchester Electricity Committee require tenders by June 7 for supply and erection at Barton power station of 33,000 volt and 6,000 volt main switchgear, pressure testing switchgear, &c. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Leeds City Council invite tenders for a steam turbine, three-phase alternator and exciter of 1,200 kw. capacity or thereabouts. Specifications from the manager of the electricity department, Mr. C. Nelson Hefford, 1, Whitehall-road, Leeds, and tenders to the Town Clerk, 26, Great George-street, Leeds, by 11 a.m. June 14

Hackney (London) Borough Council invite tenders for four water tube boilers, induced draught plants and fuel economisers, one 10,000 kw. turbo-alternator and exciter, surface condensing plant, two circulating motor driven pumps, E.T.H. switchgear, &c. Specifications from the borough electrical engineer, and tenders (by 7 p.m., June 9) to the Chairman of the Electricity Committee.

The Agent-General for Victoria invites tenders for four 4,500 kw. and eight 1,000 kw. 1,500 volts converter traction sets for the Melbourne and suburban electric railways. Specifications, &c., from the Agent-General, Melbourne-place, Strand, London, W.C.2; and further information may be obtained from the consulting engineers (Messrs. Merz & McLellan), 32, Victoria-street, London, S.W.1. Tenders by noon May 31.

Mr. Geo. Morrison, of Blackpool, has secured the contract for wiring 104 houses in connection with the Middlesbro' housing scheme.

Liverpool Corporation has accepted the following tenders for annual stores for the electric supply department: Callender's Cable & Construction Company, cables and accessories; Edison Swan Electric Company, insulated cables and wires.

Shoreditch Lighting Committee has accepted the tender of the British Thomson-Houston Company for three-phase switchgear, &c., for Whiston-street station; and that of the Metropolitan Vickers Electrical Company for switchgear for Coronet-street sub-station, at £4,120.

Among the orders recently received by the Electro-Mechanical Brake Company for "Emb" Unbreakable and Jointless Resistances (Maley's Patent) are the following:—Vigo Tramways (per English Electric Company), Midland Railway Company, Bournemouth Corporation (per B. T.-H. Company), Yorkshire (Woollen District) Tramways (per British Electrical Federation), and the Corporation tramways at Dover, Dunfermline, Manchester, Oldham, Sheffield and Stockport.

Bankruptcies and Liquidations.

A meeting of creditors of British Electrical Accessories, Ltd., will be held at 3, Cheapside, Bradford, to-day (May 21).

A meeting of creditors of Hydro-Electric Concessions, Ltd., will be held on May 25 at 3 and 4, Great Winchester-street, London, E.C. Claims to Mr. Walter Gain at that address.

British Electrical Accessories, Ltd., is being wound up voluntarily, and Mr. W. A. Judge, 72, Market-street, Bradford, has been appointed liquidator.

The first meeting of creditors of Geo. Fredk. Kiveron, electrical engineer, Goulders-place, Attercliffe Common, Sheffield, will take place to-day (May 21), and the public examination on June 20, at the County Court Hall, Bank-street, Sheffield.

Catalogues, Price Lists, &c.

Leaflets have been issued by the Leeds Electrical Construction Company, Charmouth-street, Leeds, which give illustrated particulars of the design and construction of the ELECTRIC FURNACES for INDUSTRIAL PURPOSES which are manufactured by the company.

Messrs. Higgs Bros., Birmingham, have issued their May list, which gives particulars and prices of the dynamos and motors which the firm can supply from stock.

The Switchgear, Fuses, &c., manufactured by Messrs. William Sanders & Company, of Wednesbury, are described and illustrated in a recent catalogue. Important extensions of the works have been made, and the firm have redesigned all their ironclad switch and fuse gear to meet all voltages up to 600. This is now being manufactured under mass production conditions. Copies of the catalogue may be obtained on application.

In a recent folder of the Sterling Telephone & Electric Company, Ltd., 210-12, Tottenham Court-road, W.1, illustrated particulars and prices are given of the company's new pattern "Equipoise" Flexible Telephone Arm. This up-to-date device effects an important economy of time and trouble, and is of great utility in factories and offices. The arm is made of the best steel, bronzed and relieved; it is not liable to get out of order and its balance is perfect in every position. The company supplies various patterns of the brackets according to the position in which it is intended to be placed. The folder also gives prices of the attachments for use with the arm.

A pamphlet entitled "Autophone No. 2," which has been issued by Messrs. Siemens Brothers & Company, Ltd., of Palace Court-mansions, W.8, gives illustrated particulars of the working of the Siemens Automatic Telephone System. The apparatus required for an installation comprisers user's instruments, central switching apparatus and twin wiring between instruments and switching apparatus. The exchange equipment described is designed for 50 line units, but it can be readily extended by 10-line panels up to a capacity of 200 lines. Similar exchanges can be supplied extensible to practically any number of lines. The pamphlet gives particulars of the features of the central switching apparatus, method of operation, &c. It is claimed that the system is absolutely secret in operation, gives automatic indication whether desired line is engaged or not, a quick and reliable service independent of manual operators, and it is easily extended, while the wiring is the simplest possible.

Business Items, &c.

The registered office of Electro Magneto Motors, Ltd., has been removed to 1, First-avenue, Acton Vale, London, W.3, and Mr. E. P. Cutliffe has been appointed secretary.

Joseph Camaroff and Louis Harris, electrical engineers, 11a, Cross Stamford-street, Leeds, have dissolved partnership. Debts by Mr. Camaroff, who continues the business in his own name at the same address.

Wm. Aneurin Roderick and Robert Scott (trading at the Electrical & Mechanical Trades Supply), Russell-buildings, St. Mary-street, Swansea, have dissolved partnership. Debts by Mr. Roderick, who continues.

The partnership between Beverley Nadin, Walter Wright and Percy J. Dell (trading as the Economic Electric Company), 60, Knutsford-road, Warrington, has been dissolved so far as regards Mr. Walter Wright. Debts by Mr. Nadin and Mr. Dell, who continue the business as the Economic Electric Company.

The Benjamin Electric, Ltd., have been appointed sole selling agents by the Moto-Meter Company (Inc.) for the Boyce moto-meter. The device is intended for use on motor cars, and indicates the temperature of the water in the radiator, thus notifying the driver of any undue overheating 15-20 minutes before he would otherwise be aware of the fact by engine trouble.

Messrs. Buckley, Saunders & Company, Ltd. (E. A. Chantler) have secured the agencies for South America for the Wild-Barfield electric furnaces, also for the Argentine for the A. I. Manufacturing Company's electric welding machines. Demonstration plants are already erected and working at the works in Buenos Ayres, and can be inspected by applying at the offices, 314, Bme Mitre. A demonstration Wild-Barfield electric furnace will also be in operation shortly in Rio de Janeiro.

For many years the British Thomson-Houston Company have dealt with an enormous volume of business through their Cardiff office, and since the war this business has increased tremendously. To meet this contingency the Company now occupy much larger premises at 7, Park-place, a few doors from the old address. The telephone number remains Cardiff 4,392. At the new office it will be possible to hold considerably larger stocks than heretofore, especially lighting appliances and accessories.

An interesting demonstration of the application of ELECTRIC WELDING to building operations was given at the works of Messrs. Stelfast Wheels, Ltd., by Messrs. the Alloy Welding Process, Ltd. The ground floor area of these works is about 22,000 sq. ft., the structural steel work for all of which has been welded by the A. W. P. process. An exhibition of roof trusses which are being manufactured from steel bars, angles, &c., by means of the A.W.P. electric welding process was also given. These trusses are intended for the stables at the forthcoming Royal Naval and Military Tournament at Olympia.

Patent Record.

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

December 16, 1920.

31,452 Taylor. Methods of distribution on alternating-current systems.
31,472 King. Mounting of rotary shafts for motors, dynamos, &c.
31,500 Connaughton & Railing. Relays for signalling.
31,501 Connaughton & Railing. Electric signalling apparatus.
31,511 Brantom & Hitton. Apparatus for use in telegraphy control of electrically operated apparatus at a distance, &c.
31,519 Edison Swan Electric Co. & Freedman. Spotlight lamps.
31,534 Oliver. Lamp-holders.
31,561 B.T.-H. Co. (G.E. Co.) Electric machines.
31,569 Hills. Switches.
31,572 Radio Limited, Donisthorpe & Williams. Telegraph and telephone apparatus
31,573 Franklin. Aerial systems for wireless telegraphy.
31,575 Rabbidge. Magneto-electric transformers. (19/12/18, Australia.)
31,580 Wilson Welder & Metals Co. Arc welding electrodes.

December 17, 1920.

31,617 Kenyon. Electric welding.
31,627 Gush. Insulators for electrolytic systems.
31,642 Gush. Purification of liquids by electrolytic treatment.
31,651 O'Neil. Signalling and indicating devices for ships.
31,665 B.T.-H. Co & Whitaker. (G.E. Co.) Electric machines.
31,673 & 31,674 Robinson. Wireless reception apparatus.
31,681 Escamez. Rotor and stator elements for turbines.
31,695 Gustafsson. Apparatus for issuing receipts from electricity meters, &c.

December 18, 1920.

31,711 Roddis. Electric heat producing element.
31,775 Haddon. (Hall.) Coin collecting devices for telephone services.
31,776 Haddon. (Hall.) Meter registers and control devices for telephone services.
31,786 B.T.-H. Co. & Whitaker. (G.E. Co.) Electric machines.
31,788 Maschinenfabrik Oerlikon. Mixed electric drive for vehicle equipped with steam turbines, polyphase generators and asynchronous motors. (30/10/19, Switzerland.)
31,789 Maschinenfabrik Oerlikon. Controlling polyphase generators on vehicles.
31,806 Perfect Refillable Fuse, Inc. Refillable fuses. (18/12/18, U.S.)
31,814 Johanson & Stören. Treating weakly magnetic iron ore containing sulphides as a secondary constituent.
31,815 De Becker. Incandescent lamps.
31,834 McLean & Muir. Apparatus for traction systems.

December 19, 1920.

31,876 Wilkinson. Electrically controlled valves for steam, hot water, &c.
31,880 Hortix. Telegraph and telephone systems.
31,891 Villiers Engineering Co., Farrer & Pountney. Contact-breakers for magnetos, &c
31,895 Monson. Medical electrical light and heat treatment couch.
31,898 B.T.-H. Co. & Martin. (G.E. Co.) Electric machines.
31,899 Hastings & Laycock. Electric furnaces.
31,920 Vandervill & Midgley. Switchboards.
31,923 Imperial Trust for Encouragement of Scientific and Industrial Research. Siphon apparatus.
31,927 Loth. Enabling movable object to pursue an electrically stated out route.
31,940 Riley & Kearton. Telephones.
31,942 Edison Swan Electric Co., Freedman & Percival. Lamps.

December 20, 1920.

31,953 Portway. Switches.

December 22.

32,040 Taylor. Method of transmission to alternating current systems.
32,060 Scrivener. Telegraph and telephone insulators.
32,064 Jack & Scott. Electric coal cutting machines.
32,066 Brook & Hirst. Automatic switches.
32,068 Hunter & Jack. Electric coal cutting machines.
32,080 Chambers. Production of electric oscilliations for radio-telegraphy or telephony.
32,090 B. T.-H. Co. (G. E. Co.). Protective devices for electric circuits.
32,136 Haamlooze Vennoots. Philips Gloerlampenfabricken & Oosterhuis. Ionic valves. (31/12/18. Holland.)

December 23.

32,164 Diver. Electric heater for wells.
32,194 & 32,195 B. T.-H. Co. (G. E. Co.) X-ray apparatus.
32,197, 32,199 & 32,200. Bullimore. Electric lamps.
32,206 Adams. Trip mechanism for ignition devices.
32,244 Donisthorpe. Thermionic valves.

December 24.

32,280 John. Incandescent lamps.
32,289 Annacker. Switches, &c.
32,295 Crowther & Robinson. Thermionic amplifiers.
32,311 England. Electric vaporizer.
32,327 Holder. Electrically operated mechanism for driving clockwork trains, &c.
32,346 Bechoff. Circuit controllers.
32,347 Bechoff. Indicators for controlling switches.
32,371, 32,372 & 32,373 Boardman. Arc lamps, &c.
32,404 Cohen & Miller & Zsinkovits. Portable electric lamps.
32,405 Dranes, Johnson & Franklin. Wireless telegraph system.
32,413 Smith. Aerial systems for wireless signalling.
32,425 Igranic Electric Co. & Curtis. Housing of switchgear.
32,409 Quinoneri. Magnetic separators for ferrous ores.

December 29.

32,450 Simplex Conduits, Ltd, Waterhouse & McLoughlin. Electric heaters.
32,451 & 32,452 Hope. Switches, &c.
32,454 Automatic Telephone Mfg. Co. (Smith & Harrison.) Telegraph printing systems.
32,465 Taylor. Method of transmission with alternating current systems.
32,491 Collaghan & Smith. Electric liquid heater.
32,495 Hockley. Telephone receivers, transmitters, &c.
32,517 Cohn. Duplex cable signalling.
32,523 Walker. Electro-Magnetic impulse mechanism.
32,532 Harris. Means for producing electric power.
32,536 Dyer & Joyce. Electrical heating apparatus.
32,571 Johnson. Treating weakly magnetic iron ore containing sulphides as secondary constituent.
32,576 American Brush Magneto Corporation. Magnetos. (20/2/19, U.S.)
32,588 Soc. Anon. des Etabs L. Bleriot. Regulating mechanism for electrical installations. (28/12/18, France.)
32,597 American Brush Magneto Corporation. Magnetos (27/3/19, U.S.)

December 30.

32,611 Bulpett. Mountain blades on electric N. fans.
32,624 Woodburn. Electric welding apparatus.
32,670 Hankee. Electro-Mechanical device for producing vibratory motion.
32,687 Ferranti. Permanent magnets.
32,692 O'Leary. Electrical coils.
32,700 Bocker & Eickloff. Negative electrodes for galvanic elements.
32,701 Bocker & Eickloff. Production of galvanic elements.
32,703 Allen & North. Magnetio electric machines.
32,707 Foster Engineering Co. & Ely. Audible and visible electric signalling systems for calling attendants.
32,713 Maschinenfabrik Oerlikon. Rotors of electrical machines.
32,724 Bursill. Variable electrical resistances.

Companies' Reports, &c.

A final dividend of 1s. per share (tax free), making 10 per cent. for the year 1919, has been declared by Siemens Brothers & Company, Ltd.

The recent issue of 87,500 £1 ordinary shares of Messrs. Johnson & Phillips, Ltd., was largely oversubscribed.

The Dudley, Stourbridge and District Electric Traction Company, Ltd., has declared a dividend of 4 per cent. on the ordinary shares for the year, after placing £1,000 to reserve. £2,000 to renewals fund, carrying £65 forward.

The transfer books of the Western Telegraph Company, Ltd., will be closed from the 16th to the 23rd prox., inclusive, preparatory to paying, on the 24th June, to holders of shares (Nos. 1 to 207,930 inclusive) an interim dividend of 5s. per share (tax free) for the year ending 30th June, 1920.

The profit of the Alderley & Wilmslow Electric Supply, Ltd., for the past year was £2,259, compared with £2,133 in 1918. After deducting £1,582 interest on debenture and loans, and adding £532 brought forward, the balance is £1,209, of which the directors recommend £1,000 should be put to reserve and the balance (£209) carried forward.

A dividend of 8 per cent. has been declared by the Rhondda Tramways Company, Ltd., on the preference shares, being 4 per cent. balance for 1914 and as to 4 per cent. on account of 1915. A sum of £483 has been placed to depreciation of furniture, &c.; £8,000 to reserve and renewals account, and £25,694 for repairs and maintenance, £1,280 being carried forward.

The profit of the Arbroath Electric Light and Power Co., Ltd., for the past year was £3,628. The available balance is £3,298, and the directors recommend a dividend of 7 per cent. on the ordinary shares, which carries an increase of 1 per cent. on the preference shares. It is proposed to increase the capital of the company to £100,000, divided into 10,000 £1 5 per cent. preference shares participating up to 6 per cent., and 90,000 £1 ordinary shares.

The report of the Shanghai Electric Construction Company, Ltd., states that profit for 1919 was £154,567. Including £1,211 brought forward, the total is £155,778. There have been transferred to reserve for excess profits duty £43,000, to reserve for renewals account £10,000, to general reserve £35,000. The directors recommend a final dividend of 2 per cent., making 14 per cent. for the year, and a bonus of 6 per cent. (less tax), making 20 per cent. in all, leaving to be carried forward £3,778.

The revenue of the Submarine Cables' Trust for the year ended April 15, 1920, was £26,259 and the expenses were £1,820, leaving a balance of £24,438, to which is added £66 brought forward, making £24,504. After providing £12,372 to meet payment of the coupons, £12,066 has been transferred to redemption fund, leaving £66 to be carried forward. Since the last report 521 certificates have been redeemed (exclusive of the coupons of reversion). The trustees have sold the whole of the 912 shares in the Central and South American Telegraph Company at a premium exceeding 30 per cent. over the purchase price and the proceeds have been applied in the acquisition of certificates.

Mr. Harry Kahn, who presided over the meeting of the West London & Provincial Electric Supply Company, Ltd., on the 12th inst., said the whole of the company's income was derived from its holding in the Chiswick Electricity Supply Corporation, of which undertaking it owned the whole of the share capital. The profit of the West London Company showed an increase of £1,151 over that of 1918, mainly due to the fact that they received 7½ per cent. dividend from the Chiswick Corporation, against 6 per cent. in 1918. They proposed to pay a dividend on the cumulative preference shares of 6 per cent., and the interest in arrear for the years 1914, 1915 and 1916 of 4½ per cent per annum on the funding certificates, the balance (£251) being carried forward.

Referring to the accounts of the Chiswick Electricity Supply Corporation, Mr. Kahn said the position at Chiswick and Aberystwith had improved. Owing to removal of the lighting restrictions, Aberystwith had shown considerably improved results. The balance available for distribution was £7,918, against £6,034 in 1918, and the Corporation had declared a dividend of 7½ per cent; a sum of £2,000 was placed to depreciation reserve, and £1,208 carried forward. The outlook for 1920 seemed quite good, but with the uncertainty of prices both for fuel and labour it would not be safe to be too optimistic.

The gross earnings of the Oriental Telephone & Electric Company, Ltd., during 1919 (including dividends and interest from subsidiary companies, &c.), amounted to £124,648. After adding balance from 1918 and deducting working expenses, maintenance, &c. (£70,909), and interim dividends, debenture interest and redemption charges (£22,577), there remains £42,665. The directors recommend payment of final dividends of 3 per cent. on the preference shares, and of 6 per cent. on the ordinary shares (making 10 per cent. for the year), and also a bonus of 2 per cent. (tax free) on the ordinary shares; that £5,000 be transferred to general reserve and £2,000 to staff pension fund, leaving £11,013 to carry forward. The operations of the branches of the company and of its subsidiaries have continued to show increased revenues during the past year. The great obstacle to further expansion has been the difficulty in procuring supplies of material and their shipment to the East. An improvement is, however, already apparent, with the result that it should soon be possible to overtake arrears. For this purpose several technical assistants have been sent to the East during 1919. The reconstruction of the Singapore exchange building has been completed and the new switchboard equipment is now being brought into use. At Dec. 31, 1919 the Company had in all, 8,020 exchange and private lines in operation, a net increase of 730. The Bombay Telephone Company declared a dividend of 18 per cent. (against 16 per cent. in 1918) and the Bengal Telephone Company 8 per cent. (against 7 per cent.). The Bombay Company had 7,880 exchange and private lines (a net addition of 830) and the Bengal Company 6,846 (increase of 547). The gross revenue of the China & Japan Telephone & Electric Company has been increased, but the net result is rather less favourable than that of 1918 on account of the high price of material and labour and the adverse effect of the continued rise in exchange. The Company has 5,575 exchange and private lines, a net increase of 804. The liquidation of the Telephone Company of Egypt has not yet been completed.

The report of the West India and Panama Telegraph Company, Ltd., for the year 1919, states that the amount to credit of revenue is £116,886, and the expenses have been £101,931, leaving £14,955. With £3,626 from interest on investments and £3,222 brought forward the total is £21,803. Interim dividends of 6s. per share were paid on the first and second preference shares, leaving a balance of £10,033 which it is proposed to carry forward. The year under review, the fiftieth year of the Company's existence, has been the most disastrous in its history, the primary cause being the unprecedentedly long delay of the cable-steamer, the "Henry Holmes," at Trinidad in undergoing her third survey. It was thought that the ship would be unavailable for cable repairs for not more than six months, and that the cost would not exceed £10,000, seeing that the ship was built in eight months and cost £33,800. The ship was handed over to the Government Dock authorities in Jan., 1919, and she is still there, while there has already been spent in repairs more than her original cost. The number of cable interruptions has been about normal; but, as the cables could not be repaired, station after station has been cut off with consequent loss of traffic and deductions from the Imperial, Canadian and Colonial subsidies, to say nothing of the inconvenience and annoyance to the Governments and the public, which the directors much regret. In the first three months of the year the loss of traffic is estimated at £18,000. Every effort has been made to obtain the services of cable steamers of other telegraph companies, and on three occasions the efforts were successful, but for short periods only, as the ships were needed by their owners. The hired steamers have not been as successful as the company's ship would have been, and, from stress of weather and other causes, the results have not been satisfactory and have been very costly. An oppportunity having recently offered, it was decided to charter a cable-steamer for five months.

New Companies.

ALAMO ELECTRIC, LTD. (167,158)—Private company. Reg. May 6, capital £5,000 in £1 shares, to carry on the business of dealers in and agents for the sale of the "Alamo" lighting and power sets. First directors are H. Gaskell and W. M. Carver.

ATLAS WELDING COMPANY, LTD. (11,184)—Private company. Reg. in Edinburgh, April 30, capital £3,000 in £1 shares, to carry on the business of welders, boiler-makers, ship repairers, electricians, &c. First directors are G. G. Musted (and secretary) and Archibald H Millen. Reg. office 62, Saltoun-street, Glasgow.

H. BIRKETT, LTD. (166,873.)—Private company; reg. April 28 capital £5,000 in £1 shares, to take over the business of brass founders and finishers, engineers, factors and dealers in engineers' and electrical supplies, &c., carried on by H. Birkett. First directors are H. Birkett and T. W. Clayton. Reg. office, Little Albion-street, Hull.

C. T. BOWRING & COMPANY (INDIA), LTD. (167,358)—Private company. Reg. May 8, capital £10,000 in £1 shares, to carry on in the United Kingdom, India or elsewhere the business of manufacturers, importers and exporters of and dealers in plant, machinery, hardware, electric or mechanical engineers, &c. First directors are F. C. Bowring, Sir Edgar R. Bowring, Sir John Bowring Wimble, K.B.E., L. B. Stoddart, C. W. Bowring, E. H. Bowring Skimming and C. Bowring. Solicitor: E. V. Crooks, 14, Castle-street, Liverpool.

BRITISH "DYNAMO," LTD. (167,071)—Private company. Reg. May 4, capital £25,000 in £1 shares (15,000 preference), to carry on the business of electrical and general engineers, manufacturers of and dealers in electrical and other appliances, &c. Solicitors: Jenkins, Baker & Company, 3, London Wall Buildings, E.C.

BRITISH ELECTRIC LAMPS, LTD. (167,205)—Private company. Reg. May 7, capital £20,000 in £1 shares, to take over (1) the business of a manufacturer of and dealer in electric lamps carried on by E. R. Grote, and the business of manufacturers of and dealers in electric candles, lights and stoves carried on by the Lux Candle Company, Ltd. First directors are E. R. Grote and A. A. Barron. Reg. office: Spencer Hill-road, Wimbledon, S.W.

BRITISH GLUES AND CHEMICALS, LTD. (167,236.)—Reg. May 7, capital £2,000,000 in £1 shares (700,000 8 per cent. cumulative preference and 1,300,000 ordinary). The objects are to acquire, co-ordinate and develop the businesses of seven specified firms, and to manufacture and deal in glue, gelatine, edible and technical fats and greases, &c. The directors are W. S. Corder, (chairman), H. J. Cotes, R. Duncalfe, W. Cotes, J. E. Crinditch, E. Hindley, E. Haworth, W. Haworth, J. O. Neill, O. Quibell, W. B. E. Quibell, E. H. Quibell, G. E. Shawcross, J. D. Walker, T. Walton, F.C.A. Secretary, H. Tweedale, A.C.A. Reg. office, Imperial House, 15-19, Kingsway, W.C. 2.

EMPYRION WELDING & MFG. COMPANY, LTD. (167,212)—Private company. Reg. May 7, capital £5,000 in £1 shares, to take over the business of oxy-acetylene welders carried on by W. Kirby and A. Kirby as the Empire Welding Company. First directors are W. Kirby, A. Kirby, J. T. Tilley and J. Hill. Solicitor: O. Bird, 21, Waterloo-street, Birmingham.

FALKESLEY ELECTRICAL AND CINEMA SUPPLIES, LTD. (167,214)—Private company. Reg. May 7, capital £5,000 in £1 shares, to take over the business of film renters, agents and producers, electrical contractors, patentees of a curtain controller, &c., carried on by F. E. Clipstone. First directors are F. E. Clipstone, S. H. Brown and B. Smith. Reg. office: 6, Thurland-street, Nottingham.

LONDON ARMATURE REPAIR COMPANY, LTD. (166,916.)—Private company; reg. April 29, capital £1,500 in £1 shares, to carry on the business of manufacturers and repairers of and dealers in accumulators, dynamos, magnetos and electrical apparatus, &c. Permanent directors are F. Poulter and F. N. Feirn. Reg. office, Eastern Works, Forest-lane, Stratford, E.

MACINNES, CLARK & COMPANY, LTD. (11,166.)—Private company; reg. in Edinburgh April 26, capital £1,000 in £1 shares, to carry on the business of electricians, mechanical and electrical engineers, pattern-makers, &c. First directors are H. J. MacInnes and W. R. Clark. Secretary, D. B. Mungo. Reg. office, 18, Holland-street, Glasgow.

T. E. SLAUGHTER & COMPANY, LTD. (167.338)—Private company. Reg. May 11, capital £7,500 in £1 shares, to take over the business of manufacturers of and dealers in "Lyto" dry cell and other electric batteries carried on by T. E. Slaughter and others. First directors are Mrs. E. A. Dollar, W. H. Edridge, T. E. Slaughter and E. E. G. Boite. Reg. office: 172, Church-road, Mitcham, Surrey.

Prices of Metals, Chemicals, &c.

Tuesday, May 18.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£112 0 0	£2 0 0	—
Electro Wirebars...	,,	£114 0 0	—	—
H.C. wire basis......	per lb.	1s. 3¾d.	—	—
Sheet	,,	1s. 5½d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8¾d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 11½d.	¼d.	—
Sheet, basis	,,	1s. 4¼d.	—	—
Wire, basis	,,	1s. 3¾d.	—	—
Iron—				
Cleveland Warrants	per ton	£11 17 6	£1 10 0	—
Galvanised steel wire, basis 8 SWG	,,	£48 10 0	—	—
Lead Pig—				
English	,,	£43 0 0	£3 0 0	
Foreign or colonial	,,	40 5 0	£2 10 0	
Tin—Ingot	,,	296 0 0	—	£8 10 0
Wire, basis	per lb.	0 3 7½	—	3¼d.

Salammoniac.—Per cwt. 105s.–100s.

Sulphur (Flowers).—Per ton £21.

,, (Roll Brimstone).—Per ton £21.

Sulphuric Acid (Pyrites, 168°).—Per ton. £8 8s. 9d.

Copper Sulphate.—Per ton £47.

Boric Acid (Crystals)—Per ton £74.

Carbon Bisulphide.—Per ton £60

Sodium Bichromate.—Per lb. 1s. 11d.

Sodium Chlorate—Per lb 5½d

Rubber.—Para fine, 2s. 2½d.; plantation 1st. latex 1s. 11¼d. lb

Shellac.—T.N. Orange, 565s. to 570s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co., Ltd.

Benn Brothers Journals.

Some Features of the Current Issues

"Aeronautics":—"The Handley Page Wing"; "State Air Mails"; and "Flying Boat Hulls," by Major Linten Hope.

"The Cabinet Maker":—"The Evolution of the Bureau"; "Practical Polishing"; and "Training of Designers at Colchester School of Art."

"Chemical Age":—"Industrial Applications of Liquid Air and Oxygen (I)"; "Notes on the Nitrate Industry of Chile,' by A. Bertrend"; and "The Chemist in Politics," by T. H. Gant.

"Fruit Grower":—"The Outlook for Fruit-growing"; "Commercial Rose Growing"; and "Wholesalers and Revision of Railway Rates."

"Gas World":—"The Financial Position of the Gas Industry"; "Analyses of the Accounts of some Gas Undertakings"; and "The Place of Gas in Housing Schemes."

"Hardware Trade Journal":—"Labour Saving in the Foundry (IX.)," by Joseph Horner; "Kitchenware and Intensive Salesmanship"; and Reflections on the York (I.F.A.) Conference.

"Ways and Means":—"The Timber-frame House—Its Possibilities," by Sir Charles T. Ruthen, O.B.E., F.R.I.B.A., M.S.A.; "Mercantile Marine Officers," by Forbes Hale; and "Town versus Country," by Mrs. Graham Lacy.

Forty Years Ago.

(The Electrician, May 22, 1880.)

The Brush Light.—We understand that the Brush Electric Light Company has received an order for nearly £20,000 worth of machines and lamps from Her Majesty's Government.

The Society of Telegraph Engineers.—The next meeting will be held at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W., on Wednesday, May 26, 1880, when a Paper will be read on "A Decade in the History of English Telegraphy," by Edward Graves.

The Telephone.—The telephone is now being brought into use in the various Government establishments at Chatham. Eight have been fitted up at the School of Military Engineering; and the "Pembroke," flagship of Admiral Superintendent T. Brandreth, which is moored in the large basin at the dockyard extension, is to be brought into communication with the Medway Steam Reserve Office in the dockyard, a distance of about a mile and a quarter. The instruments in use are the Gowar Bell telephones.

The Electric Light on Board Ship.—The use of the electric light on ship-board, both as a means of interior illumination and for the prevention of accidents at night and during foggy weather, is, says the "Operator," steadily on the increase. The Sound steamers "Massachusetts" and "Rhode Island," of the Providence line, have recently been fitted up with Brush Lights, by which the halls, cabins, and dining saloons are lighted by electricity. The contract includes an electric head-light, which it is expected will prove extremely valuable in foggy and stormy weather. An exhibition of the use of the new light was given last week on board the steamer "Massachusetts." Six lights were used, each light being nominally of 2,000 candle-power, and, although the saloons were nearly as brilliant as in the daytime, the light was soft and pleasant to the eye. The comparative cost of this light is about equal to that of gas at 30 cents per 1,000 feet.

Report.—Day by day electricity becomes a more important factor than before in the civilisation of the world. There are phases in its progress which hardly come within the grasp of scientific criticism, but yet they are interesting to numbers who are, by some means or other, connected with the pure or applied science. The scientific reader may turn to our other columns: we shall not here cater for him. It is sometimes difficult to make a readable column in a scientific paper for the non-scientific reader, but we hope some readers may, sooner or later, say:—

> In all thy humours, whether grave or mellow,
> Thou'rt such a touchy, testy, pleasing fellow,
> Hast so much wit and mirth, and spleen about thee,
> There is no living with thee, nor without thee.

Arrangements for the Week.

FRIDAY, May 21st (to-day).

Wireless Society of London.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Some Methods of Eliminating Atmospherics in Wireless Reception," by Mr. P. Coursey.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "The Thermionic Valve in Wireless Telegraphy and Telephony," by Prof. J. A. Fleming, D.Sc., F.R.S.

TUESDAY, May 25th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "The Evolution of Large Bridge Construction," by Major C. E. Inglis, O.B.E. (Lecture I.).

PRIDAY, May 28th.

Royal Society of Arts.—Indian Section.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Lignite," by Prof. W. A. Bone, F.R.S.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette "Two Years as an Engineer in the Grand Fleet," by Mr. A. Arnold.

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road S. Kensington, London, S.W. Discussion on "X-Ray Spectra," to be opened by Sir W. H. Bragg, F.R.S.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "Crystal Structure," by Prof. W. L. Bragg, M.A.

SATURDAY, May 29th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Tyndall Lecture on "The Theory of Relativity," by Dr. J. H. Jeans, F.R.S.

The Editorial, Advertisement and Publishing Offices of "The Electrician" *are at* 8, *Bouverie Street, London, E.C.4. Telegrams: Benbrotric, Fleet, London. Telephone: City* 9853 (4 *lines*).

The subscription to "The Electrician" *is* £2. 12. 0. *per annum in the United Kingdom, and* £2. 14. 0. *per annum Abroad. Advertisement Rates can be obtained on application to the Manager. Advertisement copy and blocks should be received on the Friday preceding date of publication*

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,193. [Vol. LXXXIV. No. 22.] FRIDAY, MAY 28, 1920. PRICE ONE SHILLING. *By Post, 1s. 1d. Abroad 1s. 2d.*

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Notes.

Commercialism v. Technology.

It is in many ways distinctly unfortunate that the technical development of wireless telegraphy in this country has been clouded by the sensational occurrences on the commercial side with which it has been connected. While paying just tribute to the perspicacity of the interests which have established this science on a sound financial basis, we must equally regret that this same business consolidation has tended to a corresponding lack of enterprise on the technical side. The reason for this is not hard to discover. Once designs and methods are settled the grouping of interests under one head tends to stagnation rather than to progress, with the result that greater attention is paid to comparatively unimportant improvements than to the development of new ideas likely to render obsolete the equipment now being used. As we pointed out rather over a year ago, as far as we can ascertain, for there is great secrecy about these matters, progress on the technical side of wireless telegraphy in this country has not been so great as it probably would have been had conditions been different. If wireless telegraphy was approaching the asymptote of its progress this would be no great matter, but it is most regrettable that a science which has hardly started upon its career of progress should be handicapped in this way. We should like to see a wider interchange of ideas, a greater recognition of new work and a determination to push forward rather than to rest on past achievements. Real growth will depend on this being done.

The Development of the Poulsen Arc.

On another page of this issue we publish an article by Mr. C. F. Elwell, whose work in connection with the commercial development of the Poulsen arc is well known to readers of The Electrician. This system started badly and received, probably undeservedly, a bad name, from which it is still suffering to some extent. It will therefore come as a surprise to our readers to learn to what extent this system is being used, not only for short distances, but for what may be aptly called international work. The map which we publish illustrates this in striking form. From the ill-fated 30 kw. station at Knockroe to the 200 kw. stations at Rome and Lyons is a long step and could not have been accomplished without close attention being successfully paid to technical and commercial details. The system is also being satisfactorily used by our own Admiralty, and may be said with truth to be a considerable factor in the development of this form of communication. A great deal of credit for this state of things must be given unreservedly to Mr. Elwell, who has accomplished what he has accomplished in the face of almost overwhelming difficulties.

The English Doctor of Philosophy.

On another page of this issue Dr. Butler Burke discusses a point of some interest. Graduates of other universities have been admitted to Cambridge for some twenty-five years, but they have suffered under the disability of having nothing to show for their work at that seat of learning, but the ordinary B.A. or M.A. degree. This has now been altered by the institution of a Degree of Doctor of Philosophy, which will be conferred on those who have successfully passed through a post-graduate course and have fulfilled certain other conditions. This alteration, while providing for the future, has conferred, in Dr. Burke's opinion, an unmerited slight on those who, having negotiated the same course, will remain simple B.A.'s. This, he considers, is a handicap in future life, as employers fail to distinguish between various degrees of the same name, and are inclined to think more of a Ph.D. obtained, say, at some college in the backwoods of America than of a B.A. obtained at Cambridge. It is a view that is so generally held that we suppose there must be something in it. But at the same time we give employers credit for a certain intelligence in these matters and feel that the whole thing has been rather exaggerated. At the same time the B.A. degree in our older universities is too wide in its scope and an improvement is likely to result from the establishment of new distinctions confined to scientists and engineers.

Electrical Engineers and Devolution.

The proposal to hand over certain of the powers now wielded by Parliament to local legislative bodies for England, Scotland and Wales is one that is deserving of more attention from electrical engineers than it will probably receive. An increasing proportion of the time of the Houses of Parliament is now allotted to measures which are either of really first rate importance or are part of a programme for the establishment of a new world. The result is that that part of the politician's duties which should consist in controlling finance and administration is more and more neglected, since not even a Member of Parliament can squeeze more than a certain amount of work into the 24 hours. Bills promoted by local interests receive, therefore, the scantiest of consideration. From the point of view of efficiency the principle of the proposed change is therefore good. But whether the proposal that one and the same members should sit in the Imperial Parliament for part of the year and in the local Parliaments for the rest of the year is equally good is to be doubted. We should have thought it would rather neutralise the relief which these local bodies are supposed to afford to our over-worked legislators.

Government by Bureaucracy.

We, however, hope that one result will be that closer consideration will be given to the details of the various Bills presented. Under the present arrangement we are fast approaching Government by bureaucracy. A mere skeleton of a Bill is put forward by some department or local authority, and is hurried through Parliament with the minimum of examination. Subsequently, the taxpayer finds that his so-called representatives have allowed another outcrop of the bureaucratic forest to be planted, and a further demand to be made on his pocket for some object which, however good it may be in theory, has never been discussed and criticised as it should have been. Another tendency is to introduce clauses which, though they bear the mark of innocency on their surface, confer powers which are often most inequitably employed. That is one phase of present-day life to which these proposed local Parliaments might well pay attention. Another is the increasing demands made by administrative departments on the time of private individuals by requiring that all sorts of information, useful or the reverse, be furnished under heavy penalties for non-compliance. As is rather pathetically pointed out in a recent issue of "Ways and Means," a Government department's appetite for statistics is insatiable, and the oftener they are furnished with information the oftener they require more, whether they have already got it or not. The result is an ever-increasing volume of useless correspondence, a growing staff of officials, and a very natural irritation on the part of the ordinary man, who cannot order some one else to fill in the form which he receives by almost every post.

Qualifications of Municipal Officials.

A point which will be of interest to those electrical engineers who believe that something should be done to increase their political and professional status was raised in the House of Commons when the Coventry Corporation and the Wallasey Corporation Bills came up for third reading. Both these Bills contained a clause providing that only members of the Institute of Chartered Accountants and of the Society of Incorporated Accountants should be elected auditors in these two towns. Accountants belonging to other societies naturally objected, and eventually it was decided that the offending clause should be modified by making the Ministry of Health's approval a necessary preliminary to any appointment. The important point is that the Corporations concerned recognised the two professional societies were bodies able to provide qualified men. It is a recognition of professional status we should like to see carried further—even to electrical engineers. Membership of one or other classes of the Institution of Electrical Engineers should be a necessary preliminary to all but the most humble appointments in a municipally owned electricity undertaking. In many cases, of course, such membership is a matter of course; but there are others.

Legal Liability of Advisers.

Consulting engineers and others who are called upon to act in an advisory capacity will be interested in the recent judgment of the House of Lords in the case of Weld-Blundell *v.* Stephens. The facts are somewhat complicated and have led to much unnecessary litigation. The plaintiff was a gentleman who had a financial interest in an electrical company and, being irritated by a request from the manager for a further advance, wrote a letter to the defendant, his confidential adviser, instructing him to investigate the affairs of the company. The letter, which contained libellous statements about a former manager and the auditor of the company, was handed by defendant to his partner, and the latter, when he went to the office of the company for the purpose of making the investigation desired by plaintiff, accidentally dropped the document, and its contents were communicated by the manager to the persons libelled. Litigation ensued and plaintiff had to pay £1,770 for damages and costs. In order to recover this sum plaintiff sued the defendant on the ground that the actions for libel would not have been started were it not for the negligence of the defendant. The history of this action is a good illustration of the vagaries and of the uncertainty of the law. The jury found for the plaintiff and assessed the damages at £650, but Mr. Justice Darling held that the action was not maintainable and judgment was given for the defendant. On appeal this decision was reversed (by two to one) and judgment was entered for the plaintiff for the nominal sum of 20s., but without costs. Now the House of Lords (by three to two) has dismissed the appeal of Mr. Weld-Blundell, and though we sympathise with that gentleman, we think the judgments of Lords Dunedin and Sumner are right. The case was remarkable for the elaborate arguments on the duty of agents, the measure of damages in actions for negligence, and the meaning of certain legal terms, and though the plaintiff may have secured the honour of giving his name to what lawyers term a leading case, it must have been an expensive luxury.

The University of London.

Probably the most hopeful sign of the times is the great interest which is being manifested in the development of university and higher education in this country. Nearly all universities and university colleges are overcrowded and in some cases intending students have had to be refused admission. In order to provide the increased facilities which modern requirements demand several of the universities, including those of London, Bristol, Liverpool and Manchester, are appealing for large sums, but the case of London is more important and urgent than any of the other institutions. Hitherto London has been without a real university in the proper sense of the term, although the existing University has undoubtedly done excellent work under great difficulties and with limited resources. We are, therefore, pleased to see that the Government has offered a site near the British Museum for the erection of central buildings which would serve as new headquarters for the University and for some of the colleges and institutions connected with it. Though a cheaper and equally convenient site may be secured elsewhere, the site offered by Mr. Fisher has many advantages. It is centrally situated, and it is in close proximity to the British Museum, the University College, the London School of Economics and other centres of academic instruction; and provided the Senate of the University could get over the financial difficulty London might at last have a real university quarter. The main change contemplated is that the University should give up its occupation of the Imperial Institute Buildings, South Kensington, and also of the King's College, Strand. It has been calculated, however, that to provide accommodation equal to that now given at South Kensington it would be necessary to raise at least £1,000,000 for the erection and equipment of new buildings, and as the South Kensington premises are held free of rent, rates and taxes these charges might mean an annual burden of £50,000 or £60,000. We believe that the University has special claims upon the Government, upon the London County Council and the other local authorities in the Home Counties, and advantage should be taken of the present opportunity to prepare and carry out a scheme which would provide the Capital of the Empire with a real university, an institution which would not only be a centre of higher education for the greater London area but would also be in every sense an imperial university. It would form a most useful and abiding form of Imperial War Memorial, and it would form a link between the institutions devoted to scientific and commercial education in the various parts of the Empire.

Electricity v. Gas in Housing Schemes.

The various schemes for providing the country with a cheap and abundant supply of houses do not seem to be getting on very fast. From one point of view this is an advantage to many station engineers, as it gives them a little breathing space to recover from war conditions, to deal with the increasing demands for power, to put up a fight against the machinations of the Coal Controller, and generally to put their houses in order. Nevertheless, the new domestic load is one that will come along in due course, so that no time must be lost both in securing it and in making arrangements for dealing with the increasing demand which it will place upon the network. This is all the more necessary as gas engineers are fully alive to the importance of this source of revenue, and are putting forward arguments of the usual kind to show why gas rather than electricity should be the domestic fuel of the future. For instance, Mr. E. L. Oughton, of the Huddersfield Corporation Gas Department, objects to a working arrangement, of which we had not heard, whereby the lighting is to be effected by electricity and the heating and cooking by gas. So do we, though not for the same reasons. He quite rightly points out that the consumption of gas for lighting purposes is small compared with that used for heating and cooking, and that, therefore, it is better to have an " all gas " house than an " electric-gas " house. Electrical engineers may well make use of this two-edged argument.

Some Weird Figures.

When we come to questions of cost we part company with Mr. Oughton. His statement that " if gas is adopted entirely, as compared with the alternative of electricity for lighting and gas for other purposes, the saving in first cost must be from £15 to £20 per house of the artisan type " must be based on some very curious premises. As Mr. Leonard Milne showed in his recent Paper before the Institution of Electrical Engineers, the present cost of putting in a nine-light installation varies from about £19 to £11, depending on the system employed, so that, according to Mr. Oughton, the cost of installing gas is even now something less than nothing, though, as he points out, it has increased to " four times pre-war rates." Such arguments would be hardly worth considering were it not that the expense of electricity for domestic purposes is still a convenient bogey wherewith to frighten the ignorant. That bogey can, however, be laid by providing electrical energy at a price within the range of all, and by turning out cheap and convenient electrical apparatus. To do this is not easy, but it must be tackled and effected somehow. Combination is one method that will inevitably lead to success and support of the E.D.A., which is giving close attention to this question, is a means whereby any station engineer may press the benefits of electricity home to all those living in his area.

The Troubles of Co-ordination.

An example of one of the minor troubles which will probably arise from time to time during the co-ordination of the electricity supply of this country under the powers given in the Electricity Supply Act is to be found in the state of affairs now existing at Kirkcaldy. In that town the electricity undertaking is owned by the municipality. It has not altogether been a success, and for good and sufficient reasons the Electricity Commissioners have refused leave to improve or extend the generating plant. There are, therefore, four courses open. The undertaking may be sold entire to the Fife Power Company, a sufficient supply in bulk may be taken from the Power Company to supplement that obtainable from the existing station, the station may be shut down and the whole supply taken in bulk or the Power Company may be allowed to supply certain large consumers. There are obvious advantages and disadvantages in any of these courses, but the first is the one most favoured by the Town Council. It certainly relieves the town of any further responsibility; from the engineering not less from the financial point of view it is the most economical way of carrying on, and it should ensure a cheap and abundant supply of electricity.

A Curious Financial Situation.

To adopt this course would, however, give rise to a curious situation. If the undertaking is now sold to the Power Company the price payable would be the original first cost of the undertaking less depreciation and sinking fund, but excluding anything for goodwill. If, however, at any future time a joint authority is formed for that part of Scotland, as seems very probable, the Power Company will be able to sell their property, including the part purchased from Kirkcaldy, at a price which would include a sum for goodwill. It is not, therefore, surprising that the honest burghers of the town are a little grieved by the idea of selling now, nor is there any good reason why they should do so. Their best course would be to retain their station until such time as an authority is formed when they can sell not only their undertaking, but also its goodwill. In the meantime arrangements should be made with the Power Company to supply the town with what extra energy they require and for all haste to be made in the establishment of a joint authority. We are glad to see that the Commissioners approve this plan and that the Power Company are willing to assist the town in their present difficulties. It is this spirit which overcomes obstacles, and is a guerdon of future progress.

Natural and Pure Philosophy—and Other Things.

The relationships of the various branches of the electrical industry are obviously concerned almost exclusively with the sciences or, to use a term employed in the early text books, with natural philosophy. Not only so, but it is with the unimaginative and mundanely practical side of the sciences that our industries are engrossed, and with the higher realms of thought, pure philosophy and such like, they have but the most fragile connection. Still there is a connection. The most notable, perhaps, is one of which we are reminded by the publication of a work of philosophical speculation by Dr. J. T. Merz, vice-chairman of the Newcastle-upon-Tyne Electric Supply Company. The work is entitled "A Fragment of the Human Mind," and is a corollary to Dr. Merz's previous work, " A History of European Thought in the Nineteenth Century," which has a world-wide reputation. The only other company which we can think of that can vie with this North of England Power Company in its connection with these remoter avenues of thought is the St. James' & Pall Mall Company, which can boast of having one of the most subtle of philosophical thinkers, the Rt. Hon. Gerald Balfour, as a director, and as chairman, one of the most accomplished Hellenic scholars of the day, Mr. Walter Leaf. Whether any oblique ray from the dazzling empyrean of poetry will ever strike any of our industries remains to be seen. The only flicker of such genius as yet in any circles has been, we believe, confined to the flippancy of the limerick, and to verse which is, to say the least of it, *blue*. For the moment we had forgotten Mr. A. S. Barnard who must certainly receive mention as a serious poet. Coming to music, we can again hold up our heads, for though we still have to achieve "distinction" on the operatic stage, if not on the concert platform, we have Mr. James Swinburne as an eminent writer on such matters.

Institution Business.

If attendance at the Annual General Meeting is to be considered as a measure of the interest that the average member takes in the affairs of the Institution of Electrical Engineers two obvious deductions may be drawn from the meagre gathering which assembled last Thursday evening. Either the general body of members is so satisfied with the way the business of the Institution is being conducted that it feels it is waste of time to put in an appearance on this occasion or else it is so dissatisfied with the conduct of affairs that it feels that anything it could say or do would be of little use.

We do not believe that either of these alternatives is the true explanation. Doubtless there is little fault to find with the work of the Council during the past year. But there must be some criticism possible in matters of detail. Such criticism is often useful and we believe the Council welcome it. For at least it shows them that their deliberations are being carefully followed, and this in itself is in some measure a guarantee that their work will be properly done. We used at one time to be told that the Annual General Meeting would be better attended if it were held in the evening. That argument no longer holds. All the meetings are now, we are glad to say, held in the late afternoon and are well attended, so that half an hour one way or the other cannot make any difference.

Criticisms and Tactics.

As it was, Mr. Tapper's and Prof. MacGregor Morris's were the only voices raised to check the steady flow of formal business. But they at least obtained the information that the Tothill-street premises are being offered for sale. At a time when inflated prices are being obtained for this class of property this is a wise decision, and one which might have been chronicled in the report among much which is neither new or strange.

It is so many years since we last attended one of these functions that we had forgotten the procedure. But surely it is a mistake in tactics for the report to be recited *in extenso* from the Presidential Chair, especially as it had already been circulated in the Journal, admittedly to save time. Both the Council and the few unofficial members present were obviously bored by this arrangement, which might well be modified on another occasion. It, perhaps, had the effect of checking discussion, as by the time the reading was finished dinner time was imminent, but that is all that is to be said for it.

The Annual Report.

The Annual Report, which we summarise on another page, is rather a colourless document. This is partly due to natural causes, but in a greater degree it is the result of the new policy the Council has adopted of making the result of their deliberations known to the general body of members as they are arrived at during the Session. This is so desirable a procedure that we can well afford to dispense with excitement once a year.

The Building and Subscriptions.

Perhaps the most interesting paragraphs in the report are the two which refer respectively to the Institution Building and to the vexed question of subscriptions. Our home on the Victoria Embankment is still in the hands of the Government and no date for its release has yet been settled. If this delay were not so serious it would be ridiculous. War has been over for more than eighteen months and it is necessary that Government departments of doubtful utility should be deflated no less than the currency. Fortunately, the former is more amenable to pressure than the latter, and we hope it is being brought to bear. Unless the push is long and strong our chances once more of returning to the Victoria Embankment are likely to be remote.

As Mr. Roger T. Smith pointed out at the annual dinner, the return of the Institution to its own premises will mark the necessity for further large expenditure. A rent is at present being obtained, it is true, and we suppose that a certain sum in addition will be granted as compensation. But it cannot be expected that this will cover more than the reasonable repairs, and it is well known that Government departments, though perhaps not so bad as soldiers, are particularly hard on the buildings they occupy. Moreover, the net sum now being received, which amounts to some £3,850 per annum, will of course disappear when the premises are once more regained. We are not, therefore, surprised to learn that "the return of the Institution to its own premises will compel special reconsideration of financial provision for the future." This is due not only to the sum that will be required for putting the building into proper order, but to meet the increased cost of administration generally. While the latter can, to some extent, be met by increasing the subscriptions, we suggest that, following the example set by the Chancellor of the Exchequer, a levy, either voluntary or involuntary, might be made on members to liquidate the latter. Electrical engineers have in many ways done well out of the war and have at least been placed in a position, if they like to take the chance offered, to do much better. If the word levy has a nasty sound we are quite willing to substitute thank offering for it. But, in any event, we think that to clear the debt once and for all and to put the Institution finances on a sound basis without delay are highly desirable. An alternative would be to raise the entrance fees and so produce a capital sum, but this could not be anything like so speedily effective. As regards the thank offering idea an excellent example has already been set by the anonymous donor who, through Sir John Snell and Mr. Sydney Morse, has subscribed £2,000 Five per Cent. War Loan for educational purposes. This is the sort of thing which we wish was more done.

Sectional Matters.

Turning to other matters we are glad to find favourable reports not only of the Wireless Section but of the Informal Meetings and of the Students' Section. Electrical engineering is now so spreading a branch, not only of engineering but of technology that decentralisation is a necessity, and if sufficient support can be found the idea might well be carried further. The informal meetings have been criticised because the subjects dealt with were not of a sufficiently technical character. But we were always of opinion that this was the reason of their inauguration. In any event, they provide, or should do so, an excellent vehicle for the practice of extempore speaking, the standard of which, to judge by the examples to which we are often obliged to listen at some of the informal meetings, is badly in need of improvement.

Recognition of Students' Needs.

A sentence in the report regarding the Students' Section may be emphasised: "That great expansion which is taking place in all parts of the world makes it, in the opinion of the Council, of particular importance at the present time for the

Institution to have regard to the interests of the younger members." Comment is needless. A useful step has been the appointment of a member of the Council to act as liaison officer. It is a post of responsibility for which Mr. G. W. Partridge is essentially suited. We hope his successor will do equally well.

The Council and Outside Bodies.

In a paragraph near the end of the report the Council refer a little modestly to their own work, but this is compensated for by the subsequent information given which shows that they have been both active in their operations and broad in their outlook. We are glad to see that the question of the Electrical Proving House is still under consideration and that such questions as Patent Law Amendment, coal prices and supplies, overhead power lines, registration, wiring rules and secondary batteries are or have been under consideration.

The "Journal" is also one of the questions that has been under review and a proposal has been made that, with a view to economy, it should be divided into sections of interest to various groups and circulated accordingly. This may be a sad necessity, but it should be avoided if possible. We ourselves, and we have no doubt our contemporaries are in the same position, find it increasingly difficult to deal with all the matter presented to the Institution. The more necessary then that it should be easily available to all members.

We feel we are entitled to close on a note of optimism. The Institution is gradually shaking off a great many of the dry-as-dust ideas which for so long retarded its progress. We see no reason, if the present enlightened policy is continued, why it should not develop into a real power in the land.

Permanent Magnets.

One of the functions of a technical journal such as The Electrician should be to act as a digester of information. Or, to vary the simile somewhat, it should so deal with subjects in the electrical world which may come to its notice that they are reproduced in its columns in the most straightforward and readable form. The more lengthy, the more complicated and the more important the matter, the more difficult it is to do this. All these adjectives are applicable to Mr. Sydney Evershed's Paper on "Permanent Magnets," recently read before the Institution of Electrical Engineers, and what we have just said therefore explains why we have deferred publication and comment on this wonderfully suggestive document until this week.

As Mr. Evershed said in his summary, his is a Paper dealing with a many-sided subject, and we further agree with him that the thread of logical sequence is none too easily followed. He sets out to give us a clearer view of fundamental matters and to build up a theory of the permanent magnet which shall be consistent with our present-day knowledge and capable of ready application to practical problems.

A Combination of Hypotheses.

As will be seen from the abstract we publish on another page, the Paper is divided into two parts, the first of which gives an account of a theory of permanent magnetism which combines Ampere's hypothesis, Ewing's theory and Sir J. J. Thomson's theory of the atom as a system of electrons moving with high velocity in orbits about a centre. This is all to the good in these days when we are being urged to "think electronically," and this part of the Paper is an excellent stimulant and exercise in that direction. But we rather gathered from this introductory matter that we were going to be led up to some new method of designing permanent magnets which would be based essentially upon the author's combination of the various hypotheses. In that we were disappointed, for we cannot see that there is anything in the second part of the Paper—dealing with the design and predetermination of permanent magnets—which requires for its conception or understanding either the acceptance or the rejection of Ampere's hypothesis or of any elaboration thereon.

The Molecular and Other Theories.

Mr. Evershed states that our point of view naturally undergoes a great change when we substitute Ampere's elements for Weber's elements, or "current rings" for Ewing's molecular magnets. But, it may be asked, in what respect or respects do the essential ideas so far presented differ? The molecular theory states in effect that every molecule of a piece of iron behaves like a magnet and may therefore be regarded as a magnet, but how or why it cannot say. The "current ring" theory states that every molecule of a piece of iron behaves like a magnet due to a current of electricity circulating round a resistanceless orbit about it, though how and why the current originated and why the orbit should be resistanceless it cannot say. Both theories appear to agree on the questions of closed groupings in unmagnetised iron, and of orientation on magnetisation. The same conceptions seem to hold for the form of the magnetisation curve, for the idea of saturation and for the phenomenon of hysteresis.

It must not be assumed that we are in any way opposed to the current ring theory or, indeed, to any theory. We are rather putting the question, as the average intelligent electrical engineer would put it: Does Mr. Evershed's theory does help us either in our understanding of known phenomena or in its application to practice?

Permeability.

Mr. Evershed also advances the view that the conception of substances having different permeabilities might be abandoned, and that the varying fluxes produced through equal sections of different magnetisable materials subjected to equal magnetising forces are produced by the different velocities of the current rings—assuming equal orientations. If we concede that the conception of the causes which may produce different permeabilities is difficult, we consider, nevertheless, that the conception of current rings which circulate only in iron or other magnetisable substances is equally difficult; or that if it be stated that current rings circulate in all substances but that it is only the iron molecules which are capable of orientation then that conception is no less difficult.

The Effect of Part I.

We hope with Mr. Evershed that the whole question will be thoroughly looked into, and we feel that he has rendered service in thus bringing it to the general notice of electrical engineers. It is just possible that had Part I. of this Paper been read before some Institution less interested in practical matters than is the Institution of Electrical Engineers and had it been dissociated from the life-work of such a well-known practician in the realm of permanent magnets as Mr. Evershed, it would have been regarded with mild indifference. But as it is, it has certainly stimulated thought, and we look forward with interest to reading the author's replies to the many pregnant questions put to him by several speakers during the discussion.

The second part of the Paper met with universal approval—save for the symbols used which, as we mentioned last week, not only jarred but made the understanding of the Paper more difficult than it need have been—and we look forward to its real completion in the third part, upon which Mr. Evershed is now at work.

A Method of Keeping Record of Cable Repairs.

By W. SCHÖNAU (Engineer retired, Great Northern Telegraph Co.)

I suppose that every cable engineer has his own pet method of keeping records of cable repairs, and that these methods are many and also serve their purpose. As I, however, have found my own method particularly useful through many years of use, and know that others have also found it so, this may perhaps serve as an excuse for giving it a wider publicity in the hope that it may become still more useful. A record of cable repairs may seem only a small matter, but I am sure that all cable engineers will agree with me that a well-kept record of the various repairs in a cable saves many hours in the year spent in looking up references in old splice lists and reports, particularly if the cable happens to be old and subject to frequent interruptions.

The annexed diagram showing a section of a cable from about 200 to 260 miles from the cable hut will perhaps serve to illustrate the method, when the following explanation is added.

The record is preferably kept on squared paper in book form, or folded up concertina-like, each page being about 24 in. long, and comprising about 60 miles of cable, or, still better, kept on millimeter paper, where each centimeter might represent 1 mile of cable. As shown in the diagram, the cable is laid down giving not only details of lengths and types—heavy lines representing heavy types—but also depths of water, &c., and if the cable happens to be passing close to the shore some landmarks might also be added. In the present case it will, for instance, be noticed that the cable is passing abreast of Black Island, 210 miles and abreast of Cape Cook, 236 miles from the cable hut.

The various repairs are marked down by two lines, the upper lines representing cable picked up, the lower line cable laid out. The position of the break is also marked as well as the condition of the cable, the nature of the bottom and particulars of types picked up and laid out. If spare cable be laid out this might be shown in red in order more easily to distinguish it from relaid cable. Other details that might be added will also easily suggest themselves, for instance, the insertion of test results may come very useful.

If splices from one repair are picked up in a later repair, they are connected by lines, as in this manner it is more easily seen that they have been removed and references to the splice lists thereby facilitated.

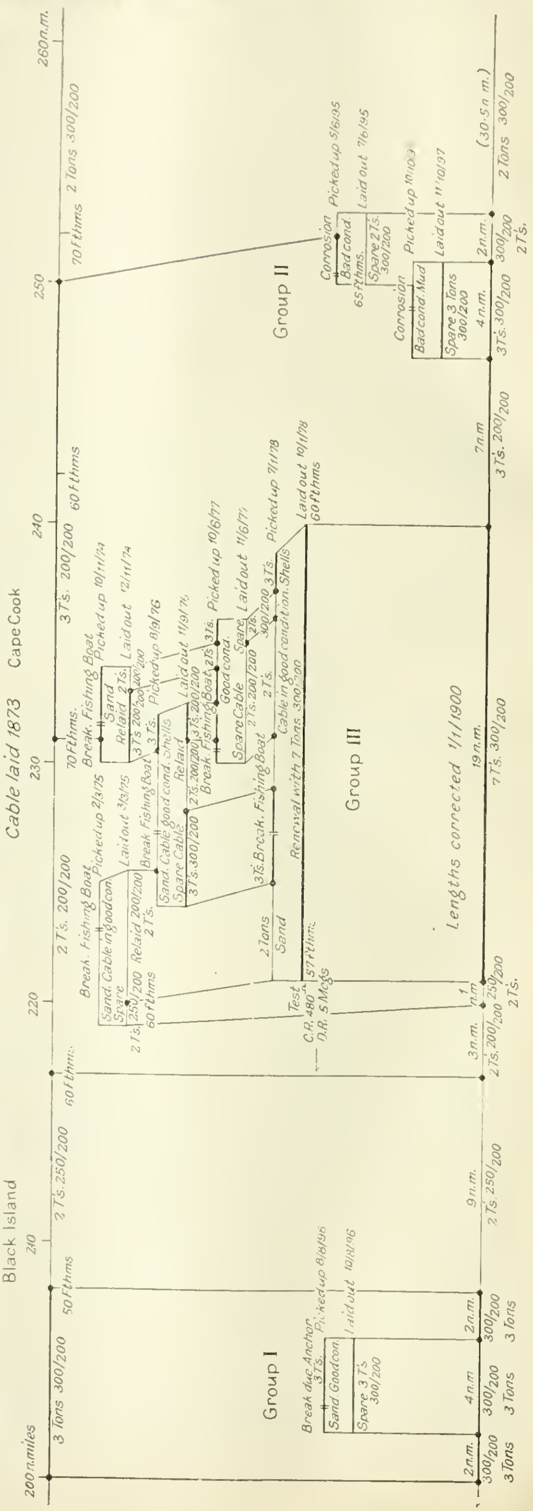
If a record of the various repairs in a cable has been kept in this manner for years, the history of the cable will be seen at a glance, and many interesting and useful inferences may be drawn from it.

For instance, referring to Group III. in the diagram we find that shortly after the cable was laid in 1873 it was evidently found that it crossed a fishing bank about 230 miles from the cable hut, as repairs due to fishing boats are crowded together about this time. It was, therefore, deemed advisable to renew it with a heavier type (7 tons) from 221 to 240 miles from shore, and this remedy evidently was satisfactory as no repairs have since taken place in this locality.

Referring to Group II. we notice that in a repair in 1895 a break was found being due to corrosion, and that the cable generally was in a bad condition, and that in a subsequent repair in 1897 in the same locality the break was also due to corrosion, and the cable also in a bad condition; it, therefore, seems reasonable to infer, that the cable in this locality is weak and wants renewal.

On the other hand, we find by referring to Group I. that the cable in a repair in 1896 due to an anchor was still in good condition; the interruption may, therefore, so to speak, be neglected and the locality also seems safe enough as only this solitary interruption has taken place since the cable was laid.

If the cable has been subjected to many repairs it will, however, be found as years pass that in records kept in this manner the position of the splices are altered in respect to their original position, owing to the lengths picked up and laid out often being different; it may, therefore, sometimes be advisable to introduce a correction of the lengths as shown in the diagram as having been done in 1900. In such a correction it will be found useful to add the lengths in miles of the various pieces in order to facilitate references to the splice lists.



Permanent Magnets in Theory and Practice.*

By S. EVERSHED.

PART I.

INTERNAL MECHANISM.

Explanations of the action of permanent magnets are given in text-books, and there is much information in scattered Papers; but the literature is a disconnected record of facts, without any full account of the modern theory of permanent magnetism, and affording no basis for numerical predetermination. The first part of this Paper outlines the theory of permanent magnetism favoured by the author. Equations are subsequently described; and in the second part examples of predeterminations are given.

THEORIES OF MAGNETIC ATTRACTIVE MATTER.

There are two ways of regarding a magnet. There is the conception of magnetic poles, from which the force radiates equally in all directions, the observed forces being regarded as due to imaginary magnetic attractive matter distributed in a layer of varying thickness over the surface of the magnet. The theory assumes the magnetic matter to be of two kinds, positive and negative—north and south. Such a theory could not carry us far, and to forecast the performance of magnets of the ordinary forms used in practice we must turn elsewhere for guidance.

The work of Faraday changed the older perspective. To his mind, action at a distance was unthinkable. He saw, in imagination, lines of force extending from the magnet throughout the surrounding magnetic field, and the conception of a magnetic circuit naturally followed. On this basis Hopkinson solved the problem of forecasting the performance of a dynamo.

Following Hopkinson, the author predetermines the performance of permanent magnets by a process of step-by-step integration. The method is readily applicable to any permanent magnet in which the magnet and its external field constitute a fairly well-defined magnetic circuit, the one outstanding exception being the ordinary bar magnet of uniform cross-sectional area.

The product of the total surplus magnetomotive force into the magnetic flux constitutes the external energy of a magnet available for use in an place where it is desired to have a magnetic field or magnetic flux. The external or available energy may be readily deduced from the cyclic curve of the steel used, and the maximum external energy which can be maintained by a unit volume of any kind of steel is the criterion by which the value of the steel, as a material for permanent magnets, should be judged.

The only known source of magnetic induction is an electric current. Ampere long ago guessed that inside a permanent magnet were electric currents flowing in molecular circuits. The molecular current is now no longer in doubt, and permanent magnetism must be explained in terms of Ampere's hypothesis and Ewing's well-known theory. The fact that any small particle of steel in a permanent magnet is itself a little magnet long ago suggested the idea that the ultimate elements of molecular or atomic dimensions were also, in effect, permanent magnets. Various hypotheses of an artificial kind were devised to account for the peculiar relation between the applied force and the resulting magnetisation.

When the cyclic character of the magnetisation curve had been recognised, Ewing swept away the rather fantastic hypotheses for the control of the magnetic molecules by showing that, if we supposed each molecule to be free to turn about a pivotal axis at right angles to its magnetic axis, the ordinary magnetic attractions and repulsions, which would naturally take place between neighbouring magnetic molecules, were alone sufficient to account for every characteristic feature of the highly complicated cyclic curve.

Ewing's theory was published nearly 30 years ago. Our knowledge of electrons has definitely turned the scales in favour of Ampere's hypothesis, and we may assume the existence of a molecular current, or *current ring*, carrying a permanent constant current and behaving like the actual molecule.

TERMS, DEFINITIONS AND SYMBOLS.

Symbols.—F, inherent magnetomotive force or "motive force," per centimetre length; f, motive force expended inside the magnetised body, per centimetre length; φ, surplus motive force of a magnetised body, per centimetre length. $F=f-\varphi$; $\mathbf{H}$, extraneously applied motive force acting inside a magnetised body or mass of current rings, per centimetre length; R, r, magnetic reluctance; k, magnetic conductance; B, magnetic flux; $\mathbf{B}$, resultant flux density created by the combined action of F and $\mathbf{H}$; β, the magnetic induction, *i.e.*, a magnetic condition in space created by the inherent magnetomotive forces of a magnetised body or oriented mass of current rings. When an extraneous motive force, $\mathbf{H}$, is present, $\mathbf{B}=\beta+\mathbf{H}$, numerically; V, the total surplus motive force available for use outside a magnet; i, the strength of the electric current in a current ring, or magnetic molecule; s, the area of the current ring or molecular circuit; $\mathbf{N}$ the number of current rings or magnetic molecules per cubic centimetre; d, the average distance between the centres of contiguous magnetic molecules; $X\,Y$, rectangular coordinates will be used. The magnetic circuit is supposed to be drawn as a development in a straight line, the magnetic axis being the axis of x; θ, the effective angle to which the current rings in a magnetised body have been oriented. It is the angle of inclination between the effective or resultant direction of the magnetic axes of a mass current rings, and the axis of y or Y direction. θ is an angle such that $n \sin\theta$ is the algebraic sum of the sines of the individual angles of inclination of n current rings.

THE MOTIVE FORCE OF ORIENTED CURRENT RINGS.

Suppose that a piece of unmagnetised iron (*i.e.*, a mass of current rings in which the orientation angle is zero) has been subjected to the magnetic field of an extraneous motive force acting in the X direction. Then, using the notation given above, the author shows that the effective motive force of the oriented mass will be

$$F=4\pi ni=4\pi si\mathbf{N}\sin\theta.$$

When θ is a right angle, the motive force per centimetre attains its maximum value $F_m=4\pi si\mathbf{N}$ and $F=F_m\sin\theta$.

SYSTEMATIC DISTRIBUTION OF CURRENT RINGS

A piece of iron, once magnetised, retains some of the magnetisation after the removal of the extraneous magnetising force. The oriented current rings are, therefore, in equilibrium when the iron is in the permanently magnetised state; the algebraic sum of the torques acting on any current ring is zero. Assuming the atomic currents to be constant, any two or more current rings will tend to turn on their pivotal axes in directions which will increase their joint energy. Hence, a mass of rings cannot be in stable equilibrium if the magnetic axes of the rings are pointing indifferently in all directions. Movements of rotation would go on until some systematic grouping of motive forces had given rise to a number of bonds of mutual induction holding the whole mass of rings in stable equilibrium. In the original Paper the author presents diagrams illustrating these conditions.

In a piece of iron or steel, of sufficient size to contain a large number of crystals, there will be tribes of molecules regularly formed in parallel lines of groups. After orientation in the X direction, the magnetic axes of the concentrated groups will point in every possible direction while they are arranging themselves during the transitional stage. Under the action of an extraneous field in the limit, every ring might be oriented to 90 deg. But on the removal of the extraneous field the current rings will return to the angular position they naturally occupy as members of locally oriented groups. The principle of maximum energy strongly suggests the tribal condition, and there is experimental evidence pointing to the same conclusion. The existence of tribes of molecules implies tribal boundaries of some kind. In crystalline substances, like iron and steel, each minute crystal may constitute a tribe.

THE EQUILIBRIUM OF A MASS OF CURRENT RINGS.

The torques acting on the average current ring in an oriented mass will arise in four ways—namely, (1) from the useful induction β in the X direction, this being what may be called the principal torque; (2) from the transverse induction β_t, due to the tribal condition, which may be referred to as the tribal torque; (3) from the rate of change of the mutual induction of closed or self-contained groups; and (4) from the rate of change of the mutual induction of oriented groups. These four torques are inherent in the oriented system of current rings and there may, of course, be a torque arising from an applied field created by an extraneous motive force. In the original Paper expressions for these various torques are suggested.

TORQUE EQUATIONS.

Assuming the presence of an extraneous motive force, $\mathbf{H}$, acting in the X direction, and creating a field numerically equal to $\mathbf{H}$, there will be an applied torque $\mathbf{H}si\cos\theta$ in addition to the inherent torques, and the equation of equilibrium will be $G=P+\mathbf{H}si\cos\theta$. When $\mathbf{H}$ is applied in the negative direction, and reduces the remanence flux in the X direction to zero, we have

$$\mathbf{H}si\cos\theta=s^2i^2-\mathbf{N}(gu_1-jv_1),$$

where u_1 and v_1 stand for the particular values of u and v when θ has fallen from the remanence value to zero. The value of negative extraneous force which brings about this condition is called the coercive force $\mathbf{H}=-s^2i^2\mathbf{N}(gu_1-jv_1)$.

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*Abstract of a Paper read before the Institution of Electrical Engineers.

When there is no gathering together of current rings into concentrated groups, q and i are zero, and in that case $\mathbf{H}$ becomes zero. A material in which the magnetic molecules, of equal magnetic moment, were distributed with absolute uniformity, would have no coercive force in the ordinary sense; group contentration and coercive force, therefore, go together.

Differential Permeability.

One of the significant facts connected with highly magnetic materials like iron is the magnitude attained by the ratio $\delta\beta/\delta\mathbf{H}$, the differential permeability. If there is no gathering together of magnetic molecules into more or less separated groups, there will be no margin of positive stability, and the differential permeability of the material will be infinite.

No such material is known to us, but in pure soft iron values of $\delta\mathbf{B}/\delta\mathbf{H}$ as high as 20,000 have been observed. The introduction of carbon into iron are probably the result of some departure from an almost perfect uniformity of molecular spacing in pure iron. Without the margin of stability thus caused the permanent magnet would be an impossibility.

The extreme smallness of the margin of stability in iron and steel will, perhaps, be realised more easily by comparing the principal positive torque acting in a piece of permanently magnetised iron, with the feeble negative applied torque which suffices to upset the balance, and bring about a reduction of the orientation angle, inherent motive force and induction to zero. Thus, the author presents a table showing that for annealed iron containing a small percentage of silicon the percentage instantaneous difference between +*ve* and −*ve* torques is only 0·13 per cent, and in a hardened tungsten magnet steel 0·64 per cent. Apparently in iron, and particularly in silicon iron, the departure from uniformity of molecular spacing is very slight. Even in the case of hardened tungsten magnet steel, concentration has apparently not gone very far. Hence, it may be impossible to produce a magnetic material which, in virtue of a far higher degree of concentration in the groups of magnetic molecules, would possess a much greater coercive force than is obtained in the magnet steels now in use.

The author also points out that orientation angle, motive force, induction and torques are interdependent, and that the equilibrium equation which he obtains serves to explain how the relation of β to $\mathbf{H}$ depends on the previous history of the iron.

Disturbance of Torque Equilibrium.

Equilibrium is the result of a delicate balancing of mechanical forces within the mass of current rings, and its maintenance depends on each contributing factor remaining constant. Although we cannot turn individual current rings round on their pivotal axes, it is easy to jerk some of the rings round in a haphazard fashion by mechanical shocks of vibration. In that way considerable changes in θ and in the induction may be brought about. The same thing may be done more systematically by heat, and doubtless in other ways. The apparent ease with which a change in the magnitude of the molecular current might be effected by electromagnetic induction was long regarded as a difficulty in Ampere's hypothesis. But it would require an enormous magnetic field—100,000 gauss or more—to induce a change of even one ten-thousandth part in the molecular current. Hence the current is, for all practical purposes, a permanent and constant quantity, and likewise the factor s, the size of the molecular circuit, must remain constant.

In the presence of an extraneous motive force the whole flux density is $\mathbf{B} = \beta + \mathbf{H}$, and the principal torque will be $\mathbf{B}si\cos\theta$. Its value may be changed either by changing the magnetic conductance of the circuit or the value of the extraneous motive force; two equivalent modes of changing the magnitude of the flux density on which the principal torque and the equilibrium of the current rings depend.

Magnetic Circuit and Ohm's Law.

The two modes of changing the flux in a magnetic circuit correspond to the alternative ways of altering the current in an electric circuit by changing the resistance, or by making an addition to the E.M.F. The nearest electric analogy to the circuit of an ideal permanent magnet maintaining a magnetic flux in external space is a battery maintaining a current in an external resistance; the point of difference being that the inherent motive force of the magnet varies with the flux, whereas the motive force of the battery is substantially constant.

The complexity introduced by the presence of a magnetic substance like iron has nothing to do with conducting power. On the hypothesis of molecular currents and one universal magnetic medium, the word permeability ceases to have any meaning. The complexity is due to the conditions of equilibrium among the oriented magnetic molecules; and, once equilibrium is established, the numerical relation between magnetomotive force and flux in a perfect magnetic circuit is as simple and direct as that of E.M.F. and current in an electric circuit. There will, therefore, be the same numerical equality between the surplus motive force in an extended magnetic circuit and the negative motive force applied to a self-absorbed magnetic circuit (for the same change of flux density) as in the analogous but simpler case of electric circuits.

The author demonstrates this by assuming two identical magnetic circuits in the form of a ring of steel, assuming first that the circuit is extended by severing the ring and introducing an air gap. Next he takes the case of the application of an extraneous motive force in the negative direction, applied, for example, by a coil wound round the ring and carrying a current. In the two cases the changes are so executed that, in the final state, the density $\mathbf{B}$ in the second case is equal to the induction β in the first case. It is shown that the surplus motive force per centimetre in the first circuit is then numerically equal to $\mathbf{H}_2$, the value of $\mathbf{H}$ which makes the final flux densities equal.

Thus, notwithstanding the complicated conditions of equilibrium in a mass of current rings, the ultimate relation between the two magnetic circuits is precisely analogous to that of the extended and self-absorbed electric circuits. For equivalence of magnetic change, the positive surplus motive force per centimetre of steel in the extended circuit must be numerically equal to the negative extraneous motive force per centimetre of steel, applied to the self-absorbed circuit.

The expressions for maximum equivalent current and maximum intensity of magnetisation, comparing a permanent magnet with an equivalent solenoid, are:—

Maximum equivalent current $I_m = si\mathbf{N}$
Maximum intensity of magnetisation $J_m = si\mathbf{N}$

Maximum Equivalent Current in Iron.

Ewing has demonstrated that the induction created by the inherent magnetomotive forces of iron cannot be increased beyond a maximum of about 21,500 lines per square centimetre, no matter how powerful the applied orienting torque may be. The maximum induction is numerically equal to $4\pi si\mathbf{N}$ or $4\pi I_m$, since $si\mathbf{N}$ is the maximum equivalent current. Hence, in iron, $4\pi I_m = 21{,}500$, and the experimental value of I_m is, therefore, $21{,}500/4\pi$, or about 1,700. The question arises whether such a figure is compatible with what is known about electronic atoms; whether any probable number of electrons per molecule moving at any likely speed in orbits of atomic dimensions, and constituting Ampere's molecular current, would be equivalent to 17,000 amperes per centimetre. The author makes a tentative comparison between the two conditions, and concludes that the electron would have a velocity of the order $7\times10^{15}/9.10^{9}$, or 6×10^{7} cm. per second; a speed which agrees well enough with the presumed electronic velocities, being several hundred times less than the velocity of light. Ampere's happy guess at a molecular current is thus justified, and with more precise knowledge of the electron and the atom the mere arithmetic of the matter cannot fail to come right.

(*To be continued.*)

Wages and Electricity Charges.

A deputation from the Home Counties Industrial Council for the Electricity Supply Industry waited upon the Electricity Commissioners last week in order to urge that the STATUTORY CHARGES AUTHORISED for ELECTRICITY SUPPLY UNDERTAKINGS be increased, where necessary, to such a degreeas to enable them to pay such wages as may be agreed upon by the Industrial Councils as proper for the Industry; that the Minister of Transport embody an instruction that such increase be devoted primarily to such purposes and that increases be given only to undertakings carrying out the recommendations of the Industrial Councils.

The deputation was received by Sir John Snell, Sir Harry Haward and Mr. Harry Booth. Ald. Wilkinson explained that their purpose was to ask that the Commissioners might grant relief to such Companies as claimed that they were unable to pay wages in accordance with the recommendations of the Industrial Councils owing to their financial position. He asked that the relief should be conditional upon wages being paid on the scale recommended by the Industrial Councils. Mr Spencer Hawes supported the case in detail, and Mr. Meakins and Mr. W. J. Webb spoke on behalf of the Trades Unions.

In reply, Sir John Snell said he fully appreciated the position. He pointed out that various legal questions were involved, but he assured the deputation that the Commissioners would give immediate and full consideration to the views expressed by the deputation.

Some Notes on Nationalisation of Electricity Supply.

By J. M. M. MUNRO, M.I.E.E., A.M.Inst.C.E.

As the Electricity (Supply) Act 1919 is now familiar to all interested, it is needless for our present purpose to explain or criticise it. It has been accepted as, on the whole, an excellent measure—as a first step. The expected second step may modify or endorse the direction of policy. Meantime those who occupy positions of "freedom without responsibility" may contribute suggestions. In forming these, we may even permit ourselves to be influenced by questions of high national policy, individualist, bureaucratic or collectivist.

The Extension of Controlled Activities.

Though the present writer would view with dismay any attempt to extend widely over electrical power service the nationalised methods necessary for, say, postal or telegraphic work, he has long favoured an extension of the controlled activities of local authorities and the creation of local trading councils for certain essential industries. Under any new electric *regime* it is to be hoped, for example, that all those communities which are now their own local electrical distributors, will remain so and those which are not may become so. The town councils as such are not suitable undertakers for the generation and high tension distribution of widespread supplies of energy for use beyond, and therefore seldom for within, their civic areas. Yet Town Councils might also be empowered and encouraged to buy at once at a fair price the power station of any authorised undertaker established for supply in their area; and this not to hold it but to transfer it, so that the town and not the company may become chief shareholders in the District Electricity Authority as explained below.

The Position of the Electricity Commissioners.

The able and eminent men now appointed as Electricity Commissioners need no outside advice, although they will get plenty of it. But the Acts which they will administer are, as we have said, not yet complete, and many interests will be pulling as these Acts are settling into shape. The scheme herein advocated was drafted while the ill-balanced Coal Commission was sitting, but is here modified in detail to run, as far as may be, on the lines of the Electricity (Supply) Act 1919. Its main points are as follows:—

1. The Electricity Commissioners in London.
2. The Sub-Commissioners, not less than five in all, of which one would be in Scotland, and one in Wales. Each would preside over a branch office within his respective division. They would be a convenient channel of intercommunication between the Commissioners and any district electricity authority, authorised distributor, or body of consumers with a grievance. The Sub-Commissioners' soon acquired familiarity with regulations, their knowledge of local circumstances, and their degree of authority over minor matters, would relieve London of much oppressive detail.
3. The District Electricity Authorities (D.E.A.). These should be created at once. They are, or should be, not debating societies nor drags on progress, nor combines of financial adventurers, but authorised executive trading bodies, with statutory powers. They would in effect be "limited companies" with the status and some of the responsibilities and powers of local authorities. But the dividends would be restricted and the surplus would go mainly towards development and for reduction of price of power.

What the D.E.A. Would Do.

All fuel-using electricity generating stations (hereinafter called "power stations," or simply "stations" for short) would, as rapidly as circumstances permitted, be sold and transferred to a D.E.A. in exchange for D.E.A. shares. The rights and burdens of these stations would go with the stations. The D.E.A. would carry them on or, with consent of the Commissioners, could, if it thought fit, contract with existing or new undertakers in respect of maintaining and running, or even of adding to, a station so transferred; or it could close them down.

A chief object of the foregoing is that the D.E.A. may secure from power stations in profitable areas some profit to assist development in poor areas. It also consolidates the immediate control of the D.E.A. over the policy, plant and operation of all stations in and outside of towns, and would save endless future discussions and disputes. Civic or personal capital now invested in individual power stations would thus become capital invested in a D.E.A. It is a process familiar in modern commercial trading. Space forbids discussion of the points of fair finance involved.

The D.E.A. with consent of Commissioners, may build new power stations, large or small. Usually these would be central stations for the further general supply of the district, and might in some cases become the sole source of supply.

The D.E.A. might also buy from a Water Board electrical energy in bulk from and at (or close to) a hydro-electric station.

The D.E.A. would also erect (or take over for shares) all high-tension transmission lines and appliances, interconnect power stations, sell energy to isolated consumers and communities, and in bulk to towns, railways, canals and the like, also to private companies being authorised local distributors not taken over by a local authority or by a D.E.A.

Authorised Local Distributors.

Cities, towns and large villages who are, or may become, authorised local distributors shall buy in bulk from the D.E.A. and retain or provide their own low-tension feeders, distributors and services and supply energy to all consumers within (or by permission around) their own areas. Special arrangements are made for high-tension mains and other property of a D.E.A. within a civic area. Thus local authorities retain control of their own streets and bye-ways. Where a town or village is already supplied by private authorised undertakers the latter, unless bought out by voluntary arrangement with the local authority, shall continue to be authorised local distributors until at least the end of a statutory period. They shall cease, however, to own a power station but shall buy in bulk from the D.E.A. even though the source of power is a station built by them in their own area and now transferred. But the D.E.A. may enter into an arrangement with any authorised supplier regarding the continued running or extension of an existing and transferred power station on such terms as commend themselves to all parties concerned.

Where the D.E.A. and the local authority refuse, or are unable to agree, to give an electricity supply to any area within a reasonable time, an individual or a company may apply to the Commissioners for power to do so, and, if authorised, may provide or retain a power station for such supply.

So short a summary of a scheme necessarily omits much that will occur to every reader; but the following remarks may elucidate some few of these points.

Arguments against a Combine of Present Undertakers.

It may be asked, why not permit a combine of existing power companies and other authorised undertakers to continue indefinitely to be the sole authority in a district. The answer is (*a*) this would gift a monoply to one set of private traders for private profit, (*b*) any necessary public service which is essentially of the nature of a monoply and also involves considerable powers of interference with public and private property ought to be in the hands of a representative public or semi-public body; and (*c*) private traders would tend to serve the more remunerative portions of their district and neglect the development of the non-remunerative. But national development of the whole country, and the spreading out of industries are of the great purposes of the Act, secondary only to economy of national fuel supply and the providing of cheap power for manufacturing centres. Note: In some cases the operation of the scheme outlined in this article would produce a D.E.A. not wholly unlike a "joint electricity authority" of the Act of 1919.

Finance and Constitution of the D.E.A.

A further word or two may be permitted upon the finance and constitution of the type of D.E.A., which has been here proposed.

1. Of each authorised issue of shares the State through the Commissioners would subscribe for a proportion, however small. Let us be ultra-sanguine and say one-third. The Electricity Commissioners would appoint the Chairman and also members or directors representing their State shareholding.

2. Each town and county council in a D.E.A. district would be asked to declare its anticipated maximum demand for electricity to be purchased in bulk or otherwise from the D.E.A. during the approximate term of years, and be compelled to subscribe for shares in a statutory ratio to that demand. Presumably it would be cheaper for these councils to do so than to build new or extend old generating stations, even if they were permitted to do the latter. The existing generating stations, even in towns, would vest in the D.E.A in exchange for shares in the D.E.A. and this transfer would satisfy a large proportion of the compulsory share subscription. Each railway company desiring power would likewise declare a maximum demand and take up corresponding shares in the D.E.A. (but the high-tension line route facilities by railways would be a matter of bargaining within the legal limits laid down in the enabling Act). Local authorities would be empowered to borrow for the purchase of D.E.A. shares. All shares would be represented on the Board of the D.E.A. All capital schemes and large expenditure proposed by the D.E.A. must, of course, be approved by the Electricity Commissioners. As the D.E.A. would have their own technical staff and consultants, and the Commissioners have at their disposal not only their own skill and experience and that of a carefully selected staff, but also may retain consulting engineers of the highest national standing, local authorities and others would have even more ample guarantee that their money would be wisely spent than they could possibly have under the conditions now passing away.

3. If necessary the general public might have an opportunity of subscribing for redeemable shares and such shares also would be represented on the D.E.A. Land and other property or rights purchased by the D.E.A. might be paid for partly in such shares.

1. A suitable number of annual labour shares would be issued at the beginning of each financial year. These would have no capital value but would rank for dividend and would be held by the D.E.A. in trust for their entire staff. Dividends would be payable in proportion to wages or salaries earned during each year, and labour would elect directors to represent its interests on the D.E.A.

The writer of this article imagines that it might be possible to mould the foregoing sketchy suggestions into an electricity policy which would be the goal (or, as some may say, the "limit") towards which all interim electrical arrangements should tend. Wasteful competition, divided control, lack of interconnection, the contest for fruitful areas and the undue neglect of the leavings, the exploitation of a public service for private profit, financial juggling for individual or syndicated gain, all these would take end. Public services kept efficient by public criticism, would afford an open field for initiative, for energy, and for adventure. Last, but not least, all that is reasonable in the idea of nationalisation would be satisfied.

The English Doctor of Philosophy.

By J. BUTLER BURKE.

Things move slowly in this country, and the recognition of the importance of original research has taken time indeed. It was not till 1895 that the advanced student movement was initiated at Cambridge, enabling graduates of other universities to migrate thither and avail themselves of the great opportunities for investigation offered by that great University, the University which unquestionably has produced the greatest number of great men.

The advanced student was permitted after two years' residence, if his record elsewhere before matriculation at Cambridge was of a high order, to apply for the Certificate of Research by presenting a Dissertation which required to be recognised as "a work of distinction and a record of Original Research." He was then allowed to proceed to the degree of B.A., and after another four years to the M.A. The concession was deeply appreciated by the many earnest students from all parts of the United Kingdom and the Empire, as well as America and the Continent, who flocked to Cambridge for inspiration, guidance and advice.

In doing so, however, they were willing to exchange knowledge thus acquired for the material advantages that a similar sojourn in Germany might have offered them, for instead of coming away crowned with the Doctorate of Philosophy, as they would have returned from Germany, they had a bare B.A. in its stead. To those who knew its value, and they were few outside Cambridge itself, the Certificate of Research was recognised to be equivalent to a First Class in Part II. of the Tripos, and as such was valued accordingly. Not so to the outer world, to whom the Ph.D. possessed an infinitely greater prestige conveying the awe and reverence which the doctorate inspires to the non-academic mind.

Like so many pre-War articles, the Doctor of Philosophy was almost invariably "made in Germany." About two years ago, however, Oxford instituted the Degree of D.Phil., and it is understood that Cambridge will ere long follow in her elder sister's footsteps. The regulations have already been drawn up by a special syndicate, and will shortly be presented for the grace of the Senate.

The period of residence is increased to three years, but work done at other Universities may be recognised and the period reduced to one year, in certain circumstances. Candidates, however, will not be eligible after their twelfth term from matriculation. Thus the new scheme is obviously intended to apply chiefly to future research students who might otherwise proceed to the Continent for the Doctorate. No provision appears to have been made in the interests of those past advanced students, who, owing to the former regulations, had to content themselves with a bare B.A. The feeling strongly exists amongst these and their friends, that having fulfilled the conditions as to longer residence and obtained the necessary standard as testified by the testimonials from their Professors, it would constitute a slight, not to say a grave injustice, that they should not now be entitled to proceed to the Ph.D. as future students would. These restrictions, needless to say, place graduates of Cambridge at a very great disadvantage as compared with those of many foreign Universities, with whom the competition is severe, particularly in technical and industrial occupations.

It so happens that so far as educational and Government appointments are concerned the disadvantage is not so marked or keenly felt. But for those who have chosen to make science a profession the handicap is undoubtedly incalculable, since the ordinary business man or manufacturer knows nothing about University honours, and cannot be made to understand that a First Class in Part II. stands for far more than a Second Class in Part I. if the former is only a B.A. or the latter a Ph.D. of Timbuctoo.

Bearing these circumstances in mind a remarkable fact was brought to light by the Report of Consultative Committees of the Board of Education, that out of 305 graduates of British Universities trained in Research, only 79 have taken up technical work, as compared with 194 who have obtained educational appointments, and 32 who have become Government officials. This fact speaks volumes for itself, revealing, as it does, a most serious state of affairs as regards highly trained scientists, which the Universities are now rivalling each other to produce.

In taking up research as a profession, the student is dimly, if not clearly, conscious of the obstacles that lie in his path, and lack of initiative or resource, natural indolence or the absence of the spirit of adventure induces him to choose the path of least resistance. Hence the popularity of the teaching profession, with its long holidays and scanty purse. It shows a singular desire to evade, or perhaps, a wise decision to avoid the strife and competition in worlds where Germans for three decades have excelled.

Our Universities, and in particular, Cambridge, have always manifested a sincere desire to help their alumni in these dangerous paths, and it is unlikely that their progress should be hindered by any further impediments or unreasonable regulations. The Report already cited admits that those who have pursued research are on the whole better fitted for administrative work on scientific lines, but unless qualified with the easily understood hall-mark of a doctor's degree, business men prefer to regard them as specialised and academic students of the Arts rather than as practical doctors in their callings. Strange anomalies to those who know better, and sadder perhaps, for administrative posts almost invariably go to those who know least.

Another aspect of this question may be worth noting in this connection. A teacher trains many pupils, and if the majority of these become teachers in their turn their numbers must increase, not in arithmetical but in geometrical progression according to Malthus' Law of population, and teachers will in time become more numerous than their pupils; so that, as the supply exceeds the demand they will tend to extinguish each other with disastrous results to their profession and the market value of their services.

If merely in the interests of teachers, such congestion should be avoided by every reasonable facility the Universities can offer.

Institution of Electrical Engineers.

Annual General Meeting.

The annual general meeting of the Institute of Electrical Engineers was held on Thursday, May 20, at the Institution of Civil Engineers, Westminster, the President, Mr. Roger T. Smith, occupying the chair.

The President read the Report of the Council for the past year, and announced that the election of officers and ordinary members of Council for the ensuing year had resulted as follows:—

Elected.
President.
Ll. B. Atkinson.

Vice-Presidents.
Dr. W. H. Eccles.
J. S. Highfield.
S. L. Pearce, C.B.E.

Hon. Treasurer.
Sir James Devonshire, K.B.E.

Ordinary Members of Council.
F. Gill.
P. V. Hunter.
*A. H. W. Marshall.
W. Noble.
Dr. A. Russell.
*C. Vernier.

Not Elected.
*R. F. Ferguson.
J. F. Neilson.
A. P. Pyne.
F. Ryan.
W. O. Smith.

Members retiring from the College and not put forward for re-election are Mr. Roger T. Smith (President), Mr. G. W. Partridge and Mr. W. B. Woodhouse (Vice-Presidents), Sir R. A. Hadfield, Sir W. Slingo, Col. H. C. Sparks and Mr. A. P. Trotter.

Commenting upon the Report, the President said it would be seen that the net increase of membership was 994. In regard to the lapsed members, the word "estimated" was used because the position of the many members whose subscriptions lapsed during the war was not yet settled, and the number that had actually left the Institution was not yet known. For the past nine years the average increase was 186. The growth in the increase this year was no doubt due in part to members having joined who were prevented from doing so during the war, but chiefly to the increased usefulness of the Institution and the activity of the Territorial Centres and Suburban Centres. It was unfortunate to note that although the number of members subscribing to the Benevolent Fund had gone up very considerably the amount subscribed remained practically where it was before. The new benefaction to the Institution by an anonymous donor (mentioned in the Report) was an admirable example to them. At that day's Council meeting trustees had been appointed to whom the fund would be transferred. Since the Report was printed the illness of one of the leading Dutch engineers had led to a postponement of the proposed visit of a deputation to Holland. The following premiums had been awarded:—Mr. M. B. Field, Institution Premium, £25; W. H. Patchell, Ayrton Premium, £10; E. A. Laidlaw, and W. H. Grinsted, Fahie Premium, £10; J. L. Thompson, John Hopkinson Premium, £10; H. W. Taylor, Kelvin Premium, £10; G. Stead, Paris Premium, £10; Major A. C. Fuller, Webber Premium, £10; Capt. J. M. Scott-Maxwell Extra Premium, £5; Major K. Edgcumbe, Extra Premium, £5. In the Wireless Section: Capt. H. J. Round, Duddell Premium, £20; and Premiums of £10 each to Prof. C. L. Fortescue, Prof. G. W. O. Howe and Capt. L. B. Turner. Students' Premiums were awarded to Mr. Norris, £15; Mr. Scott Taggart, £15; and Mr. Webb, £15. No paper read after April 15, 1920, was considered in awarding this year's Premiums. He concluded by moving the adoption of the Council's Report.

Mr. J. Shepherd seconded the motion, and it was carried unanimously.

Sir James Devonshire, in moving the adoption of the Accounts, referred to the regrettable resignation by Mr. Kingsbury of the office of Hon. Treasurer, which he so ably filled, to the great advantage of the Institution, from 1915 to 1919. He had set a high standard of excellence, which it would be his (Sir James Devonshire's) sincere desire to follow. Reviewing the items in the accounts, he said management was up by £3,328, of which the "Journal" was responsible for £1,038, and the Territorial Centres' meetings, &c., practically accounted for the balance. On the other side, subscriptions had increased by £3,187, dividends by £364, and rents from tenants by £374, due to the letting of the upper floors of the Embankment premises at an increased rent. From a financial point of view the location of the Institution at Albemarle-street was entirely satisfactory, as the Institution benefited thereby to the extent of nearly £4,000 a year. If they had occupied the Embankment premises during the whole of last year, the accounts would have presented a very different appearance. Provision was made in the current year for £4,200 for cost of printing of the "Journal" and the year's Papers, but the matter available for publication already reached about £6,700, and, taking into account the further expected increases in cost of paper, printing and postage, he thought it would be agreed that justification for the paragraph in the Report stating that the return of the Institution to its own premises would compel special reconsideration of financial provision, and that some increase in the subscription might have to be proposed.

Major A. E. Levin seconded the motion.

Mr. W. C. P. Tapper said he did not quite understand where the £4,000 came from which the Treasurer said was gained by occupying the Albemarle premises. The investment in the Tothill-street buildings and site amounted to £19,000 odd, and the net increase was $2\frac{3}{4}$ per cent., which was very poor. He suggested that the Council reconsider the question of disposing of the premises.

Prof. McGregor Morris suggested that the market prices of investments should be shown, in order that one might see to what extent they had depreciated since the balance sheet was printed.

Sir James Devonshire, replying to Mr. Tapper, said the Government paid them £2,900 rent and also paid the rates of the Embankment building, £1,630, and heating, lighting and cleaning £500. Deducting rent, heating, lighting, &c., of the Albemarle-street premises, £1,175, gave him nearly his £4,000—actually £3,855. Though there was a depreciation in the investments, they believed and hoped there was a greater appreciation in their own buildings.

The accounts were unanimously adopted.

Votes of thanks were accorded the Institution of Civil Engineers, the Hon. Secretaries of Territorial Centres, the local Hon. Secretaries and Treasurers abroad, the Hon. Treasurer (Sir James Devonshire) and the Hon. Solicitors (Messrs. Bristows, Cooke & Carpmael). Mr. Ll. B. Atkinson referred to the great energy and ability of the gentlemen carrying on the work of the Territorial Centres, and to the immense amount of work done by Sir James Devonshire in connection with the accounts.

Mr. W. M. Selvey said he could speak feelingly of the services of the Hon. Secretaries of the Territorial Centres. His own Hon. Secretary had attended to the affairs of the Institution to the point of physical breakdown, in fact he nearly lost his life with pneumonia. Messrs. Allen, Attfield & Co. were reappointed auditors.

ANNUAL REPORT.

Since April 1, 1919, the membership of the Institution has increased from 7,023 to 8,017. This is the largest increase within the last eight years, though there have been slight increases each year since 1912, with the exception of the first four years of war. This increase is chiefly to be attributed to the increased usefulness of the Institution and to the activities of the territorial centres and sub-centres. As already announced Prof. H. A. Lorentz, of Leyden, has been elected an honorary Member.

Distinctions and Obituary.

One hundred and seventy-one military distinctions were conferred on members during the year, and 75 civilian distinctions were also conferred, including the K.C.B. on Sir R. T. Glazebrook, and K.B.E.'s on Sir James Devonshire, Sir G. K. B. Elphinstone, Sir A. Mansfield, Sir J. E. Petavel, Sir H. B. Renwick, and Major-General Sir R. M. Ruck. Fifty-five members of the Institution, including Mr. J. Ardron, Monsieur J. Banneux, Mr. M. Ruddle, Mr. D. A. Starr and Mr. A. J. Walter, K.C., died during the year, of whom nine lost their lives on naval or military service.

War Memorial.

The number of dependents of fallen members whose circumstances warrant assistance from the war memorial fund is negligible. A larger sum will, therefore, be available for a memorial in the Institution building. But the Council are anxious that no case needing assistance shall escape their notice, and members knowing of such cases are, therefore, requested to communicate with the Secretary. A book of biographies and portraits of members who lost their lives in the war is in preparation.

The Benevolent Fund and Benevolence.

The Committee of the Management of the Benevolent Fund of the Institution report that on December 31, 1919, the capital account of the fund stood at £5,709 9s. 6d., and the accumulated income at £1,750 5s. 8d. £537 7s. 8d. was subscribed during the year, and 24 grants amounting to a total of £291 5s. were made. An anonymous donor has transferred to the trustees of the Institution, as a thank-offering to God for mercies vouchsafed to him during the war, a sum of £2,000 5 per cent War Loan to assist in the education of one or more of our countrymen, not being a conscript, who has served overseas during the great war and is anxious to enter the profession of an electrical engineer; and also to promote general electrical research.

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* Those marked with asterisks were nominated by members outside the Council, the remainder being the Council's nominees.

Institution Building and Subscriptions.

The Council report, with regret, that their efforts for the reinstatement of the Institution in its buildings have so far proved unsuccessful. Arrangements are being made for a deputation of the Council to wait on His Majesty's Commissioner of Works to press for early reinstatement. The return of the Institution to its own premises will compel special reconsideration of financial provision for the future. Practically all expenses of administration and the cost of everything that the Institution has to buy have advanced since the new home was first occupied. When, therefore, it returns, it is more than probable that the revenue will fall short of the actual requirements. If the activities of the Institution are to be maintained and extended some increase in subscriptions may therefore have to be proposed

Library and Museum.

By courtesy of the Institution of Civil Engineers the library of that Institution is at the disposal of members. But the Institution lending library is available. A number of valuable acquisitions to the museum have been made during the past year, including apparatus from the laboratory of the late Sir William Crookes, O.M. The Council desire to acquire apparatus of interest in connection with the war, and members possessing, or able to obtain such apparatus are requested to communicate with the Secretary.

Territorial Centres and Students.

The representation of territorial centres on the Council by their Chairman and past Chairman keeps the various territorial committees in close touch with the work of the Council. On the other hand, the activities of the territorial committees in association with local bodies provide for a representation of the views of the Institution which would be otherwise difficult to secure. The work of the territorial centre committees is regarded by the Council as of the utmost value to the Institution. Both the Wireless Section and the informal meetings have successfully developed during the past year. As the great expansion of the work of electrical engineers, which is taking place in all parts of the world, makes it of particular importance at the present time for the Institution to have regard to the younger members, it is gratifying to note that the Students' Section has been successfully carried on and facilities available include meetings and lectures in London and certain territorial centres, the award of premiums, and the use of the lending library.

Scholarships.

The following scholarships have been awarded by the Council:—*David Hughes Scholarships*, Messrs. D. S. Anderson, B. A. Cronin and P. D. Morgan. *Salmons' Scholarships*, Messrs. H. J. Barriscale, R. Cribbes and J. C. Reid. *Paul Scholarship*, Mr. F. E. Price.

The Council's Work.

The session has been an active one, and the Council have given consideration to a number of special matters, in which work they have been encouraged by the large increase in membership, though this work involves considerable call upon their time. Among their activities may be mentioned work connected with the establishment of a national Electrical Proving House, the preparation of a memorandum on the Electricity Supply Bill, efforts to secure certain improvements in the Patents Law, the organisation of deputations to the Controller of Coal Mines in regard to coal prices and supplies, upon which subject further conferences will be held, the appointment of a Committee to consider and report on regulations for overhead power lines, and the representation of views on the Institution of Civil Engineers' Registration Bill, which, as a result is not to be proceeded with in the present session of Parliament.

The "Journal."

The heavy cost of publication of the "Journal" has had the effect of preventing the insertion of valuable matters which would otherwise have appeared. It is suggested in future the "Journal" should be divided into sections of interest to various groups and circulated accordingly.

Wiring Rules.

The Council have decided to undertake a complete revision of the Wiring Rules. A Committee, under the Chairmanship of Mr. C. H. Wordingham, has set up six sub-committees in order to deal with the work as thoroughly and as expeditiously as possible. During the year regulations for the electrical equipment of ships were published, but the Council regret that very little progress has been made in the preparation of a standard maintenance agreement for batteries.

Representation on Other Bodies.

Attention is called to the connection of the Institution with a number of other bodies, including the International Electrotechnical Commission, the British Engineering Standards Association, the Electrical Research Committee, the Electrical Development Association, the Nitrogen Products Committee, the Ministry of Transport and the proposed Society of Radiographers.

Finance.

After making full provision for contingencies, there is a margin to the good on the revenue account, for 1919, of £1,495 3s. 3d. This amount, which has been carried to the credit of the General Fund compares with £1,270 11s. 5d. in 1918, an increase of £224 11s. 10d. £875 18s. has been paid off the mortgage account, which now stands at £30,198 5s. 5d. The life compositions fund now stands at £5,523 9s. Out of this a sum of £109 10s. has been transferred to the General Fund on account of life compositions of members deceased during the year, leaving to the credit of the fund £5,413 19s. The Building Fund was augmented during the year by the sum of £885 18s., which amount was applied in the reduction of the mortgage of the building. This Fund is now being merged into the General Fund. The excess assets over liabilities amounts to £7,989 18s. 10d., showing an improvement for 1919, of £6,240 16s. 7d.

The Poulsen System of Radiotelegraphy.

History of Development of Arc Methods.

By C. F. ELWELL, E.E., Fell.I.R.E., M.I.E.E., M.Am.I.E.E.

As is well known, the Poulsen arc system of radiotelegraphy employing undamped waves was invented by Dr. Valdemar Poulsen and Prof. P. O. Pedersen, of Copenhagen, Denmark, in 1902, when the various damped wave or spark systems were still struggling with the many problems inherent in the use of damped waves. Although the Poulsen arc system showed great promise, and was greeted with many prophecies as to its future value, it made very little real progress until 1909.

History of Early Work.

The period prior to 1909 was characterised by much slow plodding work in Denmark, during which the stations at Esjberg and Lyngby, 180 miles apart, form the chief examples of what was done. The use of these stations for demonstrations to Cullercoats, in England, brought the possibilities of the system well to the front.

An English company was then formed, which erected what at that time was an ambitious project at Knockroe, in Ireland. Three masts, each 360 ft. in height, were put up; but, owing to their fragile design, they were soon reduced in height. A 30 kw. arc generator was installed, and tests were carried out with Denmark. This company became involved financially and further development of this very promising system was deferred until a later date.

American and German Recognition.

The possibilities of using undamped waves, as developed by a small Poulsen arc in hydrogen, for wireless telephony were recognised by Dr. de Forest in America, and he developed a small compact set for wireless telephony, of which some 28 were purchased and installed in the U.S. Navy in about 1908.

The Germans early recognised the inherent value of undamped waves in general and the arc method of production in particular. After many attempts to develop a system in which Poulsen's basic invention of the use of hydrogen could be avoided, the rights for Austria and Germany of the Poulsen arc patents were purchased. It is significant to note that, even at this time, the chief development work carried out by the Germans and Austrians was on field sets for military purposes. (*See* Fig. 1.)

It seems strange that the German engineers never developed the arc generator in the larger sizes, and even during the war, when material and labour were at a premium, no larger sizes were constructed.

The Poulsen Arc for Short Distance Work.

In 1909 the writer became convinced of the possibilities for development of the Poulsen arc system for long-distance radiotelegraphy. After having witnessed some demonstrations (at this time there were no commercially operated installations) between the before-mentioned Esbjerg and Lyngby stations and Copenhagen, he made arrangements for the purchase of the exclusive rights to the Poulsen system for the U.S.A. An American company was formed, and two sets (one 5 kw. and one 12 kw.) were purchased from the Danish parent company. Stations were erected at Stockton and Sacramento, two cities in California, the distance between them being 50 miles. These stations were each very similar to the station at Lyngby, in that they consisted of two 180 ft. masts carrying a double cone antenna suspended from a steel cable between the two masts. Demonstrations of wireless telegraphy, both hand speed and automatically transmitted and received high speed, and of pure articulate wireless telephony were made

Criticism was raised that two stations might work very well together, but that the advent of a third station within the range of the first two would surely be impossible. Ample proof of the impossibility of disturbing communications carried out by means of undamped waves was afforded at this time by near-by spark, or damped wave stations, which did their best to jam the interloping system, and unwittingly furnished the best advertisement to the newly budding system. In 1910 the third station was built at San Francisco, and consisted of two 300 ft. wooden lattice towers, designed and built by the writer. These towers were the forerunners of 50 similar towers which have been built, ranging in height up to 714 ft.

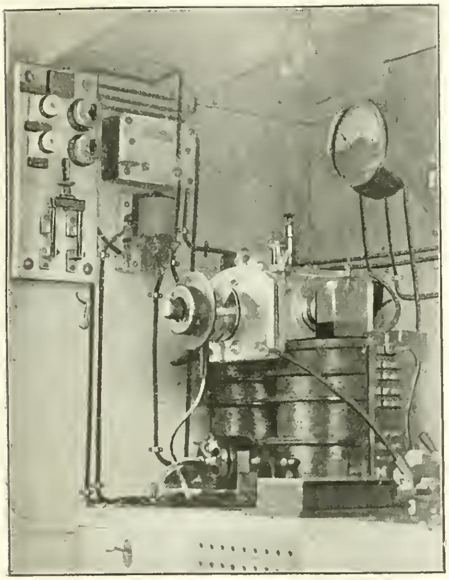


Fig. 1.—Poulsen Field Set.

The San Francisco Station.

The San Francisco arc generator was manufactured in San Francisco by the American company along the lines of the generators purchased in Denmark; but improvements were made in order to permit the use of the arc generators for long periods without over-heating the coils, fusing the anode, &c., as it was intended, and all development work was to that end, that these stations should be used in commercial work in competition with the wire lines.

Between the three stations at Stockton, Sacramento and San Francisco ample demonstration was made of the close tuning, ability to rapidly change the transmitted wave-length, absence of interference, simplicity and ease of working of the apparatus, diminished interference from atmospherics, &c.: in fact, the advantages of the system over the spark or damped wave systems then in use.

The Honolulu Station.

From this moment the technical and commercial progress of the company was rapid. Stations were built in Los Angeles, El Paso, Kansas City, Chicago, Portland and many other American cities, and, as these stations were used in commercial work in competition with the wire lines, much valuable development work had to be done by the American company in order to make the arc generators and its accessories reliable. In 1912 a second station was built in San Francisco and a new one in Honolulu. As these stations were the subject of comment in Lord Parker's Committee report, a brief description would not be out of place at this juncture.

The antenna consisted of what is known as a double cone antenna, and was attached to a steel cable 600 ft. long suspended between two wooden lattice towers each 440 ft. in height. (*See* Fig. 2.) The generator consisted of a 30 kw. arc generator, and the compactness of the apparatus can be gathered from the view of the wireless room at Honolulu shown in Fig. 3.

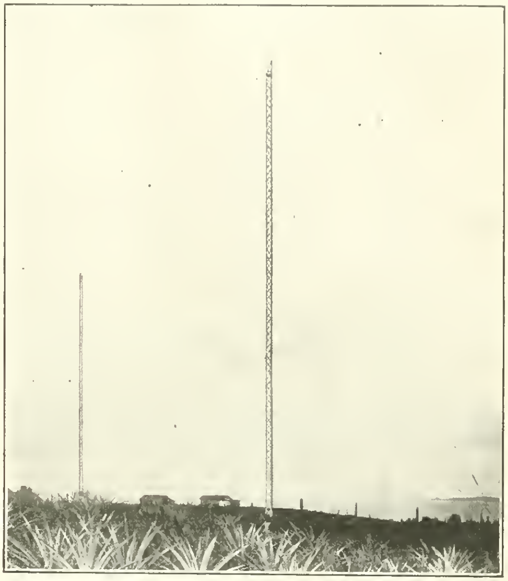


Fig. 2.—Masts at Honolulu Station.

The power plant at Honolulu consisted of a 60 h.p. Union oil engine driving two 14 kw. Westinghouse direct-current 500-volt generators operated in parallel. A second engine was installed later. Although the distance was 2,400 statute miles, these two stations communicated with one another continuously from their inception in 1912.

Development of a Press Service.

The effect of these pioneer long-distance stations on the life of the people of these islands can be gathered from the fact that a

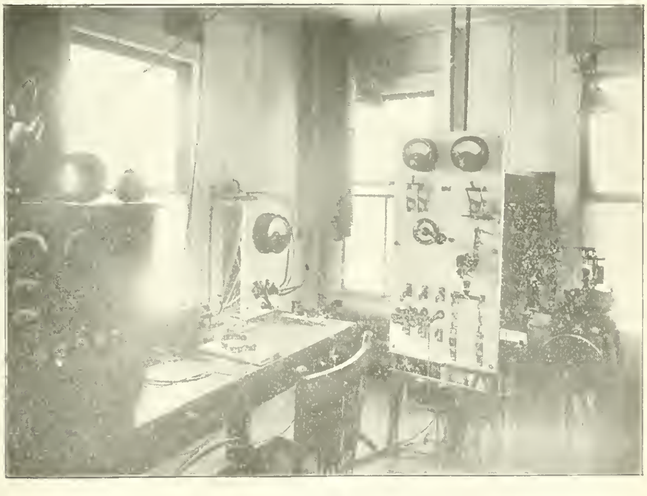


Fig. 3.—Wireless Room at Honolulu

press service of a guaranteed minimum of 1,500 words per diem was immediately entered into with the "Honolulu Advertiser," at a rate of about two cents per word; whereas, up to the advent of the wireless, the readers of this newspaper had to be content with from 80 to 120 words per diem about the world's happenings of chief interest and importance. These words transmitted by the cable from San Francisco cost 16 cents a word. The islanders paid 35 cents a word for their cables to San Francisco, which the wireless company promptly reduced to 25 cents, and a large business was promptly built up, as the cable company, by letting the wireless company do the San Francisco–Honolulu business, was enabled to handle more traffic to the Phillipines and Japan at a very lucrative rate.

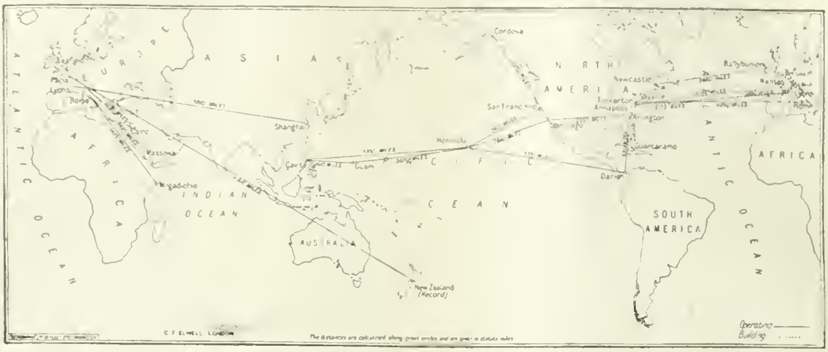


Fig. 4.—Showing Poulsen Arc Services.

The Arlington Station.

The next step in the development was the installation of a similar 30 kw. arc to that used at San Francisco and Honolulu in the U.S. Naval station at Arlington, near Washington. This station was at that time the finest station in the world. Its antenna consisted of three self-supporting steel towers, of which two were 450 ft. in length and one 600 ft.

A Fessenden 100 kw. damped-wave set was installed, and gave about 108 amperes in the antenna. The arrival of the 30 kw. arc gave an opportunity for comparative tests of the value of undamped waves versus damped waves. Although the arc set was only rated 30 kw., it gave 54 amperes in the antenna. Tests of the strength of the received signals were carried out at various stations. At distances of a few hundred miles the strength of the received signals was proportional to the energy transmitted which was proportional to the square of the antenna currents. This showed that the question of absorption does not become apparent until transmission over greater distances be involved. The final tests to Colon, on the Isthmus of Panama, a distance of 1,800 nautical miles, resulted in a clean victory for the 30 kw. arc over the 100 kw. spark set. In addition, the arc set corresponded with San Francisco and Honolulu, a distance of upwards of 5,000 miles. The results of these tests, and others made with the same 30 kw. installation, was the adoption by the U.S. Navy of the Poulsen arc system, and the ordering in 1913 of a 100 kw. set for installation in their station at Darien, on the Isthmus of Panama. This station has three towers each 600 ft. high.

From June, 1913, the development work in the U.S.A. was continued by the Federal Telegraph Company's engineers, under the direction of L. F. Fuller, and the many large arc sets now in use by the U.S. Navy are the result of this development. The U.S. Navy has at the present time 10 high-power (more than 100 kw. input) arc stations in operation over distances of from 1,600 to 5,300 miles. (*See* Fig. 4, which shows the principal high-power Poulsen arc stations)

Developments in the British Isles.

The writer came to England in 1913 as chief engineer of an English syndicate formed to purchase the Poulsen and Pedersen patent rights for practically the whole world. This syndicate had planned and was erecting transatlantic stations at Ballybunion on the west coast of Ireland and Newcastle, New Brunswick, Canada. Each of these stations had an umbrella type antenna in six sections supported by a central mast 492 ft. high, and surrounded by six masts each of 300 ft. Two 100 kw. arc generators, designed and manufactured in Copenhagen, were installed at Newcastle, and one 100 kw. and one 200 kw. arc generators were installed at Ballybunion. The maximum antenna current obtained was 110 amperes, with an input of 130 kw. Communication was established across the Atlantic towards the end of 1914, and in the early days of the war the stations were used to a small extent. The syndicate did not exercise its option to purchase the Poulsen and Pedersen patent rights, and a new company was formed to take up these rights, and it purchased the assets of the syndicate.

Some Recent Stations.

Towards the end of 1913 a contract was awarded to the syndicate for the erection of a complete 100 kw. Poulsen arc station designed by the writer for Horsea Island, Portsmouth, the antenna, triangular in shape, being suspended from three wooden lattice towers each 440 ft. high. During the war a hydroplane collided with one of these towers at a height of 356 ft., and became wedged in the mast. The pilot was rescued by one of the sailors attached to the station. Fig. 5 shows the avion in the mast. The arc set is rated at 100 kw. input, and is of British manufacture. This station was completed and handed over to the Admiralty in July, 1914. It was largely used during the war to keep in touch with the fleet, and greatly exceeded its guaranteed range of 1,500 miles.

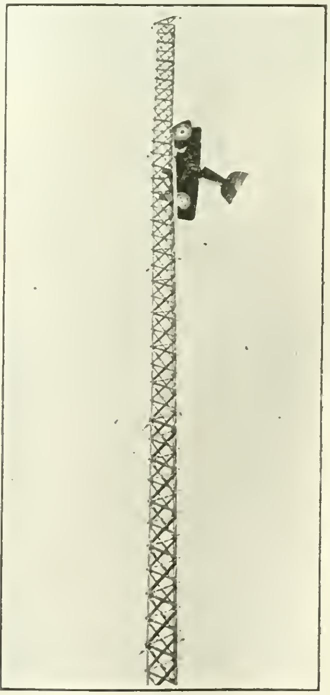


Fig. 5.—View of Horsea Island Masts with Seaplane Lodged after Collision.

In 1915 a similar arc set to the one at Horsea Island was installed in the Eiffel Tower, the antenna at the Eiffel Tower consisting of six steel wires attached to the tower itself. The capacity is low for an arc set of this size, which, not using a condenser, depends largely upon the capacity of the antenna. The set gave 110 amperes in the antenna. It was later superseded by a new installation similar to that illustrated in Fig. 7, which gave 130 amperes in the antenna.

In 1916 the Lyons station of the French Army was equipped with a 200 kw. arc set, which can be seen in Fig. 6. The antenna at this time consisted of eight steel masts, each 394 ft. high, forming a long narrow flat top antenna of large capacity. Upwards of 250 amperes were obtained in this antenna, and good communication was obtained with the U.S.A. with 200 amperes in the antenna.

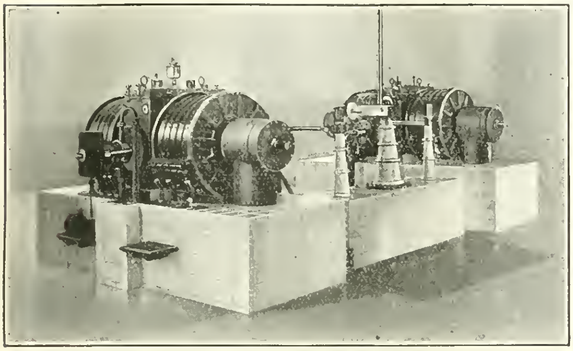


FIG 6.—POULSEN ARC CONVERTERS AT LYONS.

In 1917 the Rome station was built for the Italian Navy, the antenna (Fig. 7) being suspended from three wooden lattice towers each 714 ft. in height, arranged as an equilateral triangle with 1,000 ft. sides. The capacity of this antenna, due to the masts being of wood, is low; but the effective height is high. The current in the antenna from a 200 kw. arc generator is upwards of 180 amperes, and good communication is obtained with the U.S.A., a distance of 4,300 miles.

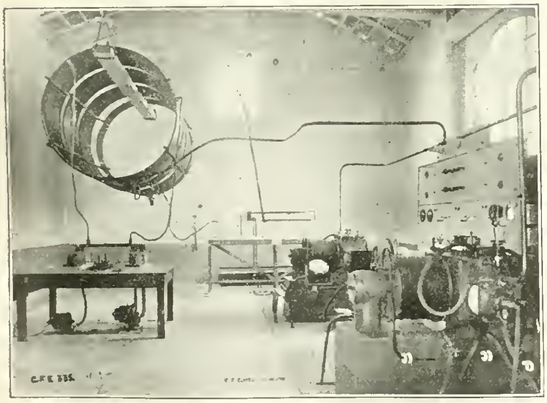


FIG. 7.—THE DUPLICATE POULSEN-ARC EQUIPMENT AT THE ROME RADIO STATION OF THE ITALIAN NAVY.

In 1917 the French Navy also built a station at Nantes, the antenna being suspended from six steel towers, each of 590 ft. in height. The 200 kw. arc generator installation at this station is similar to that shown in Fig. 7. The original 100 kw. set from the Eiffel Tower was also installed at a temporary measure.

In 1919 the towers supporting the antenna at Lyons were modified. Six of the 394 ft. towers were raised to a height of 590 ft., and two new towers each of 656 ft. were erected. A new 350 kw. arc set was installed, and gave 315 amperes in the antenna. Much better signals are received in the U.S.A., and a nightly press service is sent to Shanghai and Japan, a distance of 5,800 miles.

For the year 1920 the high-power arc-equipped stations will be represented by the installation of 250 kw. arc generators in the Leafield and Abu Zabal stations of the British Post Office. A commercial system of high-speed transmission will be installed in these two stations, which will be inaugurated later in the year.

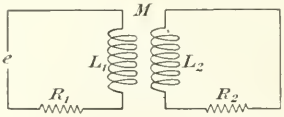
The foregoing brief outline shows that the Poulsen arc system is to-day doing a great deal of the world's long-distance wireless telegraphy. It should be pointed out that nothing has been said of smaller powered sets of from 5 kw. to 25 kw. input, of which there are well over 1,000 in existence to-day, and the vast majority of which have been designed and manufactured in Great Britain.

Correspondence.

A REMARKABLE PROPERTY OF A WELL-KNOWN ALTERNATING-CURRENT CIRCUIT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was very much interested in Mr. R. C. Clinker's letter appearing on p. 42 of THE ELECTRICIAN for January 9, 1920, a copy of which has just reached me. His reference to the rather remarkable phenomenon of decreasing primary current with increasing secondary current in a transformer whose primary is connected to an alternating current source, reminds me of a similar experience I had some years ago. Upon setting up the equations for the circuit, employing the usual "ironless mathematics," I was surprised at the simplicity of the explanation and its large independence of any capricious action in the iron circuit which was at first thought to be mainly responsible for the peculiar result. The tone of Mr. Clinker's letter and your own footnote tempts me to reproduce the cardinal parts of the original notes.



The circuital situation is depicted below with the conventional denotation of the constants.

The current in the primary circuit, denoted by I_1, is given symbolically by the expression

$$I_1 = \frac{e(R_2 + j\omega L_2)}{(R_1 + j\omega L_1)(R_2 + j\omega L_2) + \omega^2 M^2}, \quad . \quad . \quad . \quad (1)$$

which becomes after rationalisation

$$I_1 = \frac{e}{\sqrt{\left[R_1 + \frac{\omega^2 M^2 R_2}{z_2^2}\right]^2 + \left[\omega L_1 - \frac{M^2 \omega^3 L_2}{z_2^2}\right]^2}}. \quad (2)$$

For our purpose this expression will be more convenient in form if the denominator is expanded. This done, we have

$$R_1^2 + \omega^2 L_1^2 + \frac{\omega^2 M^2 (2R_1 R_2 - 2\omega^2 L_1 L_2 + \omega M^2)}{z_2^2}. \quad . \quad . \quad . \quad (3)$$

If initially we assume that the secondary is open-circuited, then $z_2 = \propto$ and

$$I_1 = \frac{e}{\sqrt{R_1^2 + \omega^2 L_1^2}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Comparison of these expressions reveals the fact that the increase or decrease in the primary current is determined by the magnitude and the sign of the factor

$$\frac{\omega^2 M^2}{z_2^2}[2R_1 R_2 - 2\omega^2 L_1 L_2 + \omega^2 M^2]. \quad . \quad . \quad . \quad . \quad (5)$$

In the present case, for decreasing primary current

$$2R_1 R_2 - 2L_1 L_2 + \omega^2 M^2 > 0, \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

or substituting $M = k\sqrt{L_1L_2}$, we have the more convenient form

$$\frac{R_1R_2}{\omega L_1\omega L_2} > \tfrac{1}{2}k^2 + 1. \quad . \quad . \quad . \quad . \quad . \quad . \qquad (7)$$

If this factor (5) is zero, there will be no change in the value of the primary current; if it is negative, the more usual thing occurs, *i.e.*, the primary current increases. Under the conditions defined by (6) or (7) upon short-circuiting the secondary coil, or as in Mr. Clinker's experiment, the mutual inductance is gradually increased with permanent short-circuit of the secondary, the primary current falls. In general, these conditions are brought about by a high ratio of resistance to reactance in both circuits with close coupling between them as indicated by the inequality (7).—I am, &c.

Philadelphia, Pa., April 30. STUART BALLANTINE.

[Mr. Ballantine has apparently not yet seen the correspondence which followed our publication of Mr. Clinker's letter.—ED. *E.*]

Electricity Works Staff.

We have received a copy of the constitution of the National Joint Board of Employers and Staffs for the Electric Supply Industry, together with the conditions of employment and schedule of salaries for technical engineers, which came into operation on May 21. The chairman of the Board, which is composed of 24 members (12 representatives of employers and 12 of employees) is Ald. W. Walker, of Manchester: the vice-chairman, Mr. J. H. Parker, of the E.P.E.A.; and the secretary, Mr. A. C. Tappenden, 1 and 2, Great Winchester-street, London, E.C. 2 The monthly meetings are held on the third Saturday of each month, and the annual meeting takes place on the third Saturday in May.

CONDITIONS OF EMPLOYMENT.

Hours of Employment.—A "week" shall consist of 48 hours. In the event of any shift worker being absent due to accident or illness, his colleagues may be called upon to work overtime for one week, and thereafter, any member who works overtime shall be entitled to equivalent time off. During the absence of a member on his annual holiday a "Relief Engineer" shall be provided if necessary. Under normal conditions the hours of duty for the "Technical Day Staff" shall be the "Office Hours" of the undertaking. In the case of members whose responsibility extends to 24 hours per day, arrangements shall be made for reasonable periods of relief.

Sick Leave.—Every member who has been in the employ of an undertaking for not less than twelve months shall, in the case of illness (unless due to wilful misconduct) be entitled to sick leave as under:—

(*a*) After 12 months' continuous service: Six months on full pay. (*b*) After two years' continuous service: Six months on full pay; and then, three months on half pay. (*c*) After three years' continuous service: Six months on full pay; three months on half pay; and then, three months on quarter pay with a minimum of £1 per week.

Holidays.—Every member shall be entitled to have all general Bank holidays, Good Friday and Christmas Day, or if called upon to work on these days shall have equivalent time off. He shall, in addition, be entitled to an annual holiday as follows: (*a*) If taken after the first eight months' continuous service, seven consecutive days; or (*b*) if taken after the first 12 months' continuous service, and after every subsequent period of 12 months, 14 consecutive days' holiday. An addition of one day to the annual holiday for each further year of service over 12 months up to a maximum of 21 days.

SALARIES.

The schedule of salaries is based upon "Plant Capacity." The term "Plant Capacity" means in the case of generating plant the maximum rated output for a continuous period of ten hours, measured in kilowatts, and in the case of rotary converting plant (which shall include frequency changers) and static transformers the maximum rated output under like conditions measured in kilovolt-amperes. Plant which has been run on commercial load shall be included from the date upon which the contractors' "maintenance period" commences.

Basic Adjustments.—The salaries of members employed in the generating stations are based upon plant capacity of the generating plant in the station in which these grades are employed, and in the undertakings where the following conditions obtain, the plant capacity shall be modified as follows: (*a*) In all cases where a generating station receives a "bulk" supply from another undertaking, or a supply from another station of the same undertaking, the plant capacity of that station shall be calculated as follows: Generating plant, 100 per cent. of the rated output in kilowatts; rotary converting plant, 40 per cent. of the rated output in kilovolt amperes; static transformers, 12½ per cent. of the rated output in kilovolt amperes. (*b*) Where entirely supplied by steam from an outside source, 30 per cent. less than the schedule salaries. (*c*) When using boilers entirely fired by waste heat and/or waste gas from an outside source, 20 per cent. less than the schedule salaries. (*d*) When partly supplied by steam or waste heat from an outside source, 10 per cent. less than the schedule salaries. (*e*) When using gas engines entirely supplied by gas from an outside source, 20 per cent. less than the schedule salaries. (*f*) In water power stations, 30 per cent. less than schedule salaries. (*g*) In all other cases, including Diesel and producer gas plants, the salaries paid shall conform to the schedule.

The salaries of members employed outside the generating stations are based on the plant capacity of the whole undertaking, and in undertakings where the following conditions obtain, the plant capacity shall be calculated as follows: (*h*) Where the whole of the power is generated by the undertaking, on the total capacity of the generating plant (auxiliaries being excluded). (*i*) Where a "bulk" supply is received and transformed, an addition to the generating plant capacity (if any) shall be made, equal to the capacity of the converting and/or transforming plant measured in kilovolt amperes. (*k*) Where a "bulk" supply is received but is not converted or transformed by the undertaking at the point of supply, an addition to the total capacity of generating plant (if any) shall be made, equal to the maximum demand of such bulk supply during the preceding financial year, measured over a period of one hour.

GRADING.

The schedule shall apply to all undertakings having a plant capacity of 1,000 kw. or over, subject to adjustment in accordance with Table 1. The basic grades are: Grade 1, deputy chief official; grade 3, power station superintendent and mains superintendent; grade 8, shift charge engineer. For members occupying positions intermediate to the basic grades, intermediate grades have been provided. Members employed in undertakings in District Area No. 10 (London) shall be entitled to 5 per cent. in excess of schedule rates, and in the case of such districts as may be agreed, they shall receive 5 per cent. less than schedule rates.

BASIC SALARIES.

For calculating the relative basic salaries, the total rate of salary and bonus as at March 1, 1920, has been adopted as a basis.

Shift Charge Engineer.—(*a*) The salary for any shift charge engineer in the lowest size of station scheduled shall be £293 per annum, subject to adjustment in accordance with Table No. 1. (*b*) In any station where the shift charge engineer is being paid in excess of the amount to which he would be entitled by the application of grade 8 he shall continue to be paid such excess amount. (*c*) In any station the highest paid shift charge engineer shall be paid not less than the amount to which he is shown to be entitled by the application of Grade 8. (*d*) In any station where differences in pay exist between shift charge engineers, the lower paid shift charge engineers shall continue to receive the same relative percentage difference less than the highest paid shift charge engineer. If these figures be less than grade 8 they shall be brought up to grade 8 by not more than three equal annual increments.

Power Station Superintendent.—(*a*) In a station where the power station superintendent is being paid in excess of the amount in grade 3, he shall continue to be paid such excess amount. (*b*) The percentage relation between the salaries of the power station superintendent and of the highest paid shift charge engineer shall be maintained for the present, except where the salary would thereby be raised above the grade to which he belongs. (*c*) If the amount to which the power station superintendent is entitled is less than the amount in grade 4 for that size of station, he shall receive the salary fixed by grade 4 and rise to the amount shown in grade 3 by not more than three equal annual increments. (*d*) In any undertaking over 30,000 kw. the present relative percentage difference between the salaries of the power station superintendent and of the highest paid shift charge engineer shall be maintained, provided that in no case shall he receive less than £585 per annum.

Intermediate Grades.—All other grades employed in the power station shall maintain their percentage relative position to either the highest paid shift charge engineer or the power station superintendent, to whichever position they are nearest, and shall rise to the figure set out in the schedule for the grade in which they then belong, by not more than three equal annual increments.

Mains Superintendent.—(*a*) In an undertaking where the mains superintendent is being paid in excess of the amount in grade 3 he shall continue to be paid such excess amount. (*b*) The percentage relative difference between the salaries of the mains superintendent (whether he is in charge of sub-stations or not) and the power station superintendent shall be maintained, except where the salary would thereby be raised above grade 3. (*c*) If the amount to which the mains superintendent is entitled is less than grade 4 for that size of undertaking, he shall nevertheless be allocated to that grade; but if in charge of both mains and sub-stations he shall rise to the amount shown in grade 3 by not more than three equal annual increments. (*d*) All other grades employed outside the power station shall maintain their percentage relative position to the mains superintendent (whether he is in charge of sub-stations or not) and shall rise to the figure set out in the schedule for the grade in which they then belong by not more than three equal annual increments.

Deputy Chief Official.—In any undertaking over 8,000 kw. the present relative percentage difference between the salaries of the deputy chief official and the power station superintendent shall be maintained as a minimum, provided that in no case shall he receive less than £657 per annum. For all grades above the grade of station superintendent in undertakings above 10,000 kw. capacity of plant, the minimum salary shall not be less than £657 per annum; but the relative difference between these grades and the station superintendent shall be maintained.

READJUSTMENT OF SALARIES.

The salaries given in the schedule are based on an increase in the cost of living of 125 per cent. over the conditions obtaining in July, 1914. The figures given in the "Labour Gazette" shall be the basis of any readjustment of salary under this section. To meet variations in the cost of living, all salaries shall be subject to revision quarterly and for each complete 15 points variation in such cost. The necessary adjustment shall be made and take effect as from the first day of the next quarter. Such revision shall be in accordance with the figures given in Table 1.

Table 1. showing percentage adjustment of salary in accordance with the variation in cost of living.

Salaries up to £350, subject to + or − 3·6 per cent. ; from £350—425, 3·2 per cent. ; £425—500, 2·9 per cent. ; £500—550, 2·6 per cent. ; £550—625, 2·3 per cent. ; and £625—700, 2·0 per cent.

Settlement of Differences.

When questions arise as to the intent and application of the conditions and schedule, rates for additional grades, regrading, &c., the parties shall confer and endeavour to arrive at a mutual settlement. Failing such settlement, matters of difference shall be referred to the District Joint Board. Pending the setting up of such boards, or failing a settlement by the District Board, the matter shall be referred to the National Board.

Schedule of Salaries.—*Plant Capacity in Kilowatts.*

Grade.	Class A. 1,000—2,000.	Class B 2,001—4,000.	Class C. 4,001—6,000.	Class D. 6,001—8,000.	Class E. 8,001—10,000.	Class F. 10,001—30,000.	Class G. 30,001—50,000.	Class H. 50,001—100,000.	Class J. 100,001 and over.
	£	£	£	£	£	£	£	£	£
1	538	574	625	657	...	...	...	...	...
2	471	502	547	576	620	...	...	...	...
3	427	455	498	523	564	585	...	...	...
4	371	407	432	469	504	524	575	611	657
5	352	378	411	433	465	499	518	565	596
6	322	354	376	407	426	457	486	516	561
7	293	322	354	371	399	427	442	484	509
8	293	293	322	349	365	392	416	430	467
9	...	...	...	270	291	313	333	354	376
10	...	...	...	...	...	252	266	284	309

The B.E.A.M.A. Annual Dinner.

Lord Ampthill, President of the British Electrical & Allied Manufacturers' Association, occupied the chair at the Savoy Hotel on Thursday last, the 20th inst., at the annual dinner of the British Electrical & Allied Manufacturers' Association, and there were present over 400 members and guests. The company included Sir J. Fortescue Flannery, Bart., M.P., Sir Tom Callender, Sir John Wormald, Bart., C.B.E., the Rt. Hon. Lord Carmichael, G.C.S.I., Sir John Snell, Lord Vaux of Harrowden, Rear-Admiral F. L. Field, C.B., C.M.G., Lt.-Col. Sir J. Dunlop Smith, K.C.S.I., the Rt. Hon. Lord Sydenham, G.C.S.I., G.C.I.E., Sir John A. Aspinall, Sir Allan Smith, K.B.E., M.P., Sir Richard Redmayne, K.C.B., Sir J. E. Petavel, K.B.E., Sir Philip Nash, K.C.M.G., C.B., and Sir William Clark, K.C.S.I. The chairman occupied an unusually long period in disposing of the loyal toasts, but ultimately Sir John Snell rose to propose the toast of the evening, that of "The Industry." Sir John had some difficulty in making himself heard, the acoustic properties of the room being particularly poor. He first remarked upon the Government attitude towards electricity supply and to the tact that since 1916 seven departmental committees, on six of which he had himself sat, had been appointed. As a result of this work the electricity supply business was regarded as a key industry, and the Act of 1919 could be considered as a great electrical charter. The Water Power Conservation Committee had favourably reported upon the untapped resources of hydro-electric energy in Scotland and Wales. The Railway Electrification Committee and the Committee on Electroculture made it evident from their reports that immense developments were immediately ahead. Five years of war had been necessary to make known the value of industrial electric power in decreasing the cost of production and enormously increasing output. He considered that there were many years of prosperity before the industry. In 1913 1,300,000,000 units of electrical energy had been sold and 25 years were needed to reach this output. In 1919 the sale had reached 4,500,000,000 units and these figures would, in his opinion, during the next five or six years be doubled. On this account alone there was a prospect of immense development before manufacturers of steam raising and generating plant and subsidiary electrical apparatus. He characterised as nonsense the suggestion that the existing generating stations should be replaced by 16 "super-power" stations. None the less it was necessary to shut down the bad stations, to improve any of the others and to extend the plant of those undertakings where there was an urgent demand for energy. He added that he was grateful to the Government for the colleagues given him on the Electricity Commission.

Sir Charles Ellis, K.C.B., vice-president of the B.E.A.M.A., in reply, commented on the work of the Ministry of Munitions during the war, and the assistance which electric power had rendered in increasing munitions output. The prospective development before the industry would be of material assistance in paying off the country's debt. It used to be an axiom in commerce "take care of the exports and the imports will take care of themselves." Now-a-days, he suggested, that the rendering of this should be "take care of the exports in the hope that the imports will take care of themselves."

The toast of "The Profession" was given by Mr. W. L. Hichens, who put forward a special plea for a more generous support of research work. He considered that the contribution of British engineering firms to research was a disgrace and also a national danger. Without adequate research there could not be satisfactory industrial success. The universities should be efficiently equipped for carrying on research work.

Mr. Roger T. Smith, President of the Institution of Electrical Engineers, and Mr. J. Swinburne, F.R.S., replied. The latter, in order to make himself heard, stood on a chair, and pointed out the difficulties under which the salaried man labours with money at its present value. If it did not improve the best thing for this class of individual to do would be to die.

The speech-making was unrelieved by any musical programme, and it was obvious during the latter part of the evening that many of those present had other matters of interest to discuss and took advantage of the opportunity to do so. This is not surprising when it is considered that the gathering is one of manufacturers meeting under cordial conditions present and prospective customers. We commend to the Council the suggestion generally expressed that at next year's dinner those present be given time to indulge in a quiet business chat without incurring the displeasure of the Chairman.

Further Birmingham Extensions.

Another extension of the Nechells generating station is proposed by the Birmingham Electric Supply Committee at a cost of £1,757,800. It will be remembered that in July, 1918, authority was given to erect the first portion of the station at an estimated cost of £1,626,140. The capacity of this new plant is 30,000 kw., but owing to delay in the work of contruction, due to the moulders' strike and other causes, the station will not be ready to give a supply before the winter of 1921-22, except possibly to a partial extent. Further steps have been taken to supplement existing sources of supply, but present and prospective requirements are such that it is impossible to meet them to any adequate extent. The maximum daily load on the works during last winter was about 63,250 kw. The combined capacities of the power stations (including the Dunlop Company's station) is an almost identical total. There is thus practically no reserve plant, and in the opinion of the engineer (Mr. R. A. Chattock) there should be in reserve not less than 12,000 kw. to allow for normal overhaul of machinery and contingencies. The department has been compelled for some time past to impose restrictions on the use of supplies, and to refuse applications for urgent power connections. At present there are applications for 27,000 kw., and this figure would have been much greater had it not been known that the department was in a position to deal with new business. The committee therefore consider it their urgent duty to deal with the question of further extensions of plant, and they have obtained reports from the city electrical engineer and the consulting engineers who advise that the Nechells permanent station should be increased in capacity from the 30,000 kw. now in hand to 60,000 kw., by the addition of two complete sets of plant, each of 15,000 kw. capacity.

Legal Intelligence.

Responsibility of Confidential Advisers.

Last week the House of Lords (by a majority of three to two) dismissed the appeal of the plaintiff in the case of Weld-Blundell *v.* Stephens from an order of the Court of Appeal setting aside a judgment of Mr. Justice Darling, and giving judgment for the appellant.

The appellant, who had invested money in business undertakings, including the Float Electric Company, Ltd., and the manager of the Company (Mr. Hurst) having applied to appellant for a further advance, he wrote on May 4, 1915, to the respondent, who acted as his confidential adviser in financial matters, a letter containing instructions to investigate the affairs of the Float Company, and also containing statements reflecting upon Mr. W. H. Lowe (the previous manager) and Mr. Charles Comins, the auditor of the company. The respondent handed the letter to his partner (Mr. Swift) with instructions to make inquiries. Swift dropped the letter in the manager's room of the Company's offices. Hurst read the letter and communicated its contents to Messrs. Lowe & Comins, who brought actions of libel against appellant, and in each case the Judge directed the jury that the occasion of publication was privileged, but the jury found expressed malice and assessed the damages in Lowe's action at £1,000, and in Comins' action at £500, and judgment was entered accordingly. In Lowe's case the judgment was varied by the Court of Appeal, and judgment was entered for £250 in lieu of £1,000. The total sum paid by appellant in respect of those actions was £1,770, and he brought the present action to recover damages for respondent's breach of duty to use reasonable care to keep secret the contents of his letter of May 4, 1915. The jury found that it was the duty of respondent to keep the letter secret; that he neglected that duty, and that the actions for libel brought by Lowe and Comins against appellant and the damages recovered by them were the natural and probable consequences of that negligence; and they assessed the damages at £650. The judge, however, entered judgment for respondent on the ground that the action was not maintainable. The Court of Appeal, by a majority, decided that appellant was entitled to nominal damages, and ordered that judgment should be entered for him for 20s.

Lord Finlay, after reciting the facts, held that the result of defendant's negligence was that actions were brought against his principal, Mr. Weld-Blundell. There was no legal principle to exclude the damages in such actions from being taken into account in estimating the damages payable by the agent. To hold that no such damages could be recovered would be to give practical immunity in many cases to agents who had allowed the secrets of their principals to become known. The jury did not give the full sum which plaintiff had had to pay in those actions, no doubt because they thought that if plaintiff had acted reasonably the matter might have been settled on more favourable terms. It must be borne in mind that the present was an action for breach of duty by an agent in failing to take proper care of a document entrusted to him. It was admitted that he failed to discharge that duty, and the very thing happened which it was his duty to guard against. In his opinion, the judgment of the Court of Appeal should be reversed, and judgment entered for appellant for £650, the amount of the verdict, with costs.

Lord Parmoor, with hesitation, agreed with Lord Finlay.

Lord Dunedin was of opinion that there was no evidence which entitled the jury to give the affirmative answer to the question as put to them that the actions for libel and the damages recovered were the natural and probable consequence of the proved negligence of defendant. "It was the repetition of the words by Hurst to Lowe and Comins, which was the voluntary act of a free agent over whom defendant had no control, and for whose acts he was not answerable, that was the immediate cause of the plaintiff's damage. He was of opinion that the result reached by Mr. Justice Darling and the majority of the Court of Appeal was right, and that the appeal should be dismissed with costs.

Lord Sumner, who agreed with Lord Dunedin, said the only damages of which there was any evidence consisted of the damages and costs (both the successful plaintiffs' and his own) which were recovered against appellant or incurred by him in the libel actions. Either the sums which the appellant had to pay were the direct result of what he did himself and were self-inflicted injuries, or they were caused not by Mr. Stephens, but by Mr. Hurst. As to the costs, appellant brought them on himself by electing to defend what in truth were undefended actions. Appellant's liability did not depend on or spring from the defendant (Mr. Stephens), unless a mere occasion was identified in law with cause. The damages and costs were payable by reason of plaintiff's own wrongdoing and were legally recoverable from him independently of defendant's breach of obligation. It was said that the jury's third finding was conclusive because there was evidence to go to the jury, which would support it. That evidence was either respondent's admission that he realised that the letter was dangerous, or it was the general effect of the circumstances of the case as a jury would regard them. He could not see that there was any evidence in law in either case, because he could not see that the mere probability that actions might be brought for the libels could turn Mr. Hurst's act into respondent's act.

Lord Wrenbury agreed with Lord Dunedin and Lord Sumner, and the appeal was dismissed with costs.

Relief from Electricity Supply Contracts.

Last week Mr. Justice Bailhache heard an application under the Courts (Emergency Powers' Act, 1917) by Bootle Corporation for relief from an electricity supply contract with the Bootle Cold Storage and Ice. Under an agreement of Jan. 19, 1912, the Corporation undertook to supply electricity for power purposes at the Company's works for ten years, from March 1, 1912, at certain specified rates.

Mr. Miller, K.C. (for plaintiff), said that the Act gave power to the courts to give such relief, where, through the war, events had occurred to alter the whole basis of a contract. From the affdavit of the borough electrical engineer (Mr. T. D Clothier) it appeared that the supply was charged for under the agreement under two headings:—(1) To cover the capital and standing costs irrespective of the quantity used, and this rate was £1 per kw. per quarter; and (2) To cover the running costs a charge of 0·375d. per unit was made.

In 1917 the electricity works of the Corporation were declared a controlled establishment and they were carried on under the Director of Electricity Supply. New works and large extensions were constructed, at the instigation of Government departments, for producing war material, and the Corporation had to furnish electricity for them, but the Corporation could not get any sanction to the extension of their electricity works. In December, 1917, the Corporation had to get a supply in bulk from Liverpool Corporation at a price which increased the cost above that which it would have been if the Corporation had been permitted to extend their station. The price of coal had increased from 11s. 3d. per ton in June, 1914, to 36s. per ton, an increase of 220 per cent., and wages had risen by 130 per cent. In the year ending March 31, 1915, the capital and standing costs per kilowatt of maximum demand from all consumers were £1 12s. per kw. per quarter; (2) the average running cost per unit sold to all consumers was 0·435d. per unit; and the charges to defendants of £1 per kw. and 0·375 per unit were fair. In that year a profit of £3,014 was made. For the year ending March 31, 1919, the figures were much higher, and a loss of £7,670 was shown, despite increased charges to every other consumer. Costs since that date had risen to (1) £2 19s. 6d. per kw. per quarter, and (2) 1·06d. per unit. The charge to all other consumers had increased by 3¼ per unit for lighting, and not less than 0·85d., nor more than 1·7d. for power.

Evidence was given by Mr. Clothier, who said that defendants had offered to pay ¾ of the increased cost represented by the coal clause in the agreement, dating back to the beginning of 1918, or about £1,200.

On Thursday, Mr. R. A. Wright, K.C., for defendant company, said that his clients had agreed to accept the offer of the Corporation that he understood was still open to them; so that the contract by consent would be amended increasing the contract price by three-quarters of the coal clause charges as from Jan. 1, 1918, to June 30, 1919, and as to the whole of the coal clause charges from July 1, 1919, to the end of the contract. He submitted there should be no costs on either side.

Mr. Justice Bailhache: I do not agree. I think the defendants were unreasonable in the matter, they forced the plaintiffs to come here.

The contract was amended on the terms indicated, with costs.

Electricity Supply.

Barnsley Electricity Committee proposes to purchase a 500 kw. rotary converter.

East Ham Corporation has decided to lay a supply cable to the sewage works at a cost of £3,275.

Wolverhampton Corporation has authorised an expenditure of £7,000 on the electric lighting of four schools.

Wrexham Corporation has applied for authority to expend £17,250 on extensions of generating plant and mains.

There was a profit of £1,321 on the Darwen Electricity Works for the past year, against a loss of £1,140 in 1918-19

The Town Council of Perth has asked the Electricity Commissioners to sanction an extension of plant at the electricity works.

Liverpool Tramways and Electric Power and Lighting Committee propose to spend £45,000 on extensions of the electric mains in connection with the housing scheme on the Lisburn Farm estate.

Permission has been given by the Electricity Commissioners to the Mersey Power Company to supply electricity to the Manchester Dry Docks Company until the Corporation is able to give a supply.

Walthamstow Urban Council has applied to the Electricity Commissioners for sanction to borrow £95,850 for a 5,000 kw. turbo-alternator, induced draught plant and water-tube boiler, with economiser, &c., cooling tower, sub-station equipment, &c.

There has recently been an improvement in the revenue of Bath Electricity Department. This is due to an increase in charges and to an additional demand for private lighting. At the last Council meeting it was decided to discontinue street lighting during the summer, but the experiment has not proved a success, and electric lighting has already been restored.

A dispute has arisen between members of the technical staff of Wimbledon Electricity Dept. and the Corporation. In a letter to the local press, Mr. W. Arthur Jones (general secretary of the Electrical Power Engineers' Association) says the first recommendation of the National Joint Industrial Board for the electricity supply industry on the matter in dispute was that both sides should agree to an increase of £30 per annum from Jan. 1 last on the existing bonus, and the conference of local authorities owning electricity works in Greater London endorsed that recommendation. The Electric Lighting Committee recommended that the increased bonus be paid to the six technical engineers, but the Staffing Committee reported against it, and the Council adopted the Staffing Committee's suggestion. The letter protests against this action, and describes it as a challenge accompanied by every possible provocation. The Association also sent a letter to the Town Clerk on May 22, pointing out that the local members threaten that unless the recommendation to the National Joint Board is adopted by 5 p.m. on Monday, May 31, they will withdraw their services.

Electric Traction.

On the past year's working of the Reading Corporation Tramways there was a deficit of £6,787, compared with a net profit of £5,061 in 1918-19

The net profit on the Rotherham tramways is £1,593, but owing to losses on railless cars and petrol omnibuses there is a net loss of £1,907 on the whole undertaking.

During the year ended March 31 Bournemouth Corporation tramways department carried 27,080,255 passengers, against 20,769,507 in 1918-19. The total receipts were £192,048 (£149,442) and the gross expenditure £158,490, the net profits being £33,558.

The Electricity Commissioners are prepared to consider applications from local authorities, being authorised undertakers, for sanction to Loans for providing Public Electric Vehicle Charging Garages and the equipment of same. Provisional sanction has already been given to the borrowing by Ipswich Corporation of £4,000 for this purpose.

As Taunton Corporation and the local Tramway Company cannot agree as to the price to be paid by the latter for electric current for traction purposes it has been decided to take proceedings under the provisions of the Courts (Emergency Powers) Act for the annulment of the agreement between the Council and the Company. The Company pays 1·2d. per unit and the Council ask for at least 100 per cent. advance, the cost of the coal having increased from 14s. 4d. per ton when the agreement was made to 48s. Upon the present rate of consumption by the Company they would have to pay £1,200 a year for power instead of £600.

The financial position of the Leeds Corporation tramways is not satisfactory, and the Tramways Committee recommends a revision of fares to meet increased expenses. The income for the year ended March 31 was £876,526 (£862,396 from passengers, £4,860 from parcels and mails, and £2,893 from advertising), and the expenditure £299,889 (against £209,043), and after paying interest, &c., the net surplus was £83,757. The item "wages of motormen and conductors" rose from £131,515 in 1919 to £204,483 last year, and rates and taxes imposed an additional burden of nearly £6,000. The parcels traffic shows an enormous extension, for whereas in 1919, the first year of the experiment, 31,032 parcels were carried, the total last year reached 144,644. In 1919 a sum of £30,000 was devoted to relief of rates, but the Committee recommended that if in any year the receipts exceed the expenses, there shall be paid into the tramways reserve fund the amount of such excess or so much thereof as shall be necessary to provide a reserve fund amounting to £100,000

Business Items, &c.

The Birmingham warehouse and offices of Messrs. Buck & Hickman Ltd., have been removed to 23, Newton-street, Corporation-street.

Messrs. Charles P. Sparks & Partners have removed to Blackfriars House, New Bridge-street, London, E.C. 4. Telephone Nos.: Central 4725 and 4726.

The offices of Messrs. Waygood-Otis, Ltd., have been removed to 54-5, Fetter-lane, London. E.C. 4. Telephone, Holborn 2001. Telegrams, Waygood Fleet London; cables, Waygood London.

After the 31st inst. the telephone number of the West End depot (5, Arthur-street, New Oxford-street, W.C. 2) of Pope's Electric Lamp Company, Ltd., will be changed to Gerrard 6074 (2 lines). Arrangements are being made to augment the present large and varied stocks of lamps, fittings, &c.

The Reason Manufacturing Company, Ltd., has applied for an EXTENSION of the terms of Letters Patent No. 25,000/1905 for "Improvements in mercury electrolytes for electrolytic cells," and of 20,770/1905, for "Improvements in cathodes." Notice of opposition must be sent by June 9, to the Chambers of Mr. Justice Sargant, Room 317, Royal Courts of Justice, London, W.C.

Messrs. Sir W. G. Armstrong, Whitworth & Company have made arrangements to undertake the manufacture of water turbines, and have formed a hydro-electric section as a part of their civil engineering and contracting department, which is under the control of Mr. Mackenzie. The designs to which they will work are those of a Norwegian firm who have been making water turbines since 1849. The addition of Messrs. Armstrongs to the roll of hydro-electric contractors and manufacturers will be very welcome as the firm will be in a position to execute complete contracts at a time when the development of water power is of such great importance.

Following the normal trend of things in these days, an amalgamation of interests has been arranged between the Lancashire Dynamo & Motor Company, Ltd., of Manchester, and the Crypto Electrical Company, Ltd., of Willesden. It is intended that all machines below about 10 H.P. shall be manufactured at the Willesden Works, and that machines above this size shall be manufactured at Manchester. Special arrangements have been made to meet the requirements of customers who require to duplicate existing machines of either make. The Crypto Company's works, at Willesden, are being extended to double their present size, and it is hoped that these extensions, which are practically complete, will ensure the production of about four times the existing output of motors from about ¼ B.H.P. up to 10 B.H.P. The selling organisations of the two companies have been combined throughout the British Isles. The associated firms have branch offices in London, Glasgow, Newcastle, Birmingham, Dublin, Cardiff and Bristol, and full information regarding the products of both works can be obtained from any of these offices, or from the head offices and works of either firm. It is confidently felt that the increased efficiency obtained by limiting the range of manufacture of each works will greatly increase the combined output, with corresponding benefits in regard to price and delivery for the many friends and customers of both firms.

Catalogues, Price Lists, &c.

A four-page pamphlet issued by Messrs. Cole, Marchent & Morley, of Bradford, is devoted to the firm's central exhaust and heat extraction steam engines. Copies of the pamphlet or of the company's catalogue giving a fuller description of the company's central exhaust and tandem compound engines, can be obtained on application.

In Bulletin 1,000 A of the Electric Controller & Mfg. Company, of Cleveland, Ohio, particulars are given of the design and construction of the Dinkey controllers for d.c. motors manufactured by them. Various forms of plain reversing and dynamic braking controllers are illustrated and described. The company has also issued a number of net price sheets, which operate from the 1st May.

The Delta Electrical Company, of Temple Courts, Temple Row, Birmingham, have issued a pamphlet (No. 160) illustrating and describing their new patent dolly operated water-tight tumbler switch. The special features of the new switch are that it is dolly operated, permits of easy wiring, it has a special asbestos treated joint (which is permanent), and it is absolutely watertight. The company have made arrangements with the Edison and Swan Electrical Company to carry a stock at all their branches.

The 1920 price list of cables, flexibles and wires recently issued by the London Electric Wire Company & Smiths, Ltd., is issued in a handy form, and admits of easy reference. Commencing with tables of copper conductors, there follow sections devoted to rubber cables (association and non-association, &c.), to flexibles and wires of various kinds (silk and cotton covered, enamel insulated, bell and telephone and high resistance wires), cotton sleevings, dynamo brushes, ebonite jointing materials, &c. Accompanying the catalogue is a sheet giving the terms to the trade.

Though oil-firing for stationary and locomotive boilers has been extensively used for a long time in countries where are plentiful supplies of oil, it is only within recent years that the subject has received much attention in this country; but, owing to the increasing price and scarcity of coal, engineers and industrialists are now investigating the merits of oil fuel. A pamphlet recently issued by Messrs. Alldays & Onions, Ltd., of Birmingham, gives particulars and prices of their "Empire" Patent Oil Burners, together with illustrations of various types of boilers fitted with these burners. Apart from their application to steam boilers, the burners are used for furnaces and other industrial equipment.

Miscellaneous.

The petition of Messrs. R. & A. Main, Ltd., for the compulsory winding up of the Quain Electric Company, Ltd., has been withdrawn by permission of Mr. Justice Astbury.

The death is announced of Mr. A. H. Hiorns, who was for many years head of the metallurgical department of Birmingham Municipal Technical School. He was the author of several text books on metallurgical subjects.

The new Amalgamated Engineering Union, which will embrace the A.S.E., and 10 other societies connected with the engineering trades, will be formally constituted on July 1. Its membership will be nearly 500,000, and the funds are estimated at £4,000,000. The programme of the new union includes a demand for a minimum wage of £6 10s. a week for skilled engineers.

The Liberal Anti-Nationalisation Committee, who are about to inaugurate a new campaign against Nationalisation, have removed to 32, Charing Cross, London, S.W.1. They have issued the text of Mr. Frederic Harrison's address to the recent Liberal Conference, together with Lord Emmott's remarkable appeal on that occasion. The present industrial situation lends peculiar importance to both utterances.

The Hartonians Athletic Football Club, consisting of employees of the Hart Accumulator Company, of Stratford, has had a most successful football season, having won the Eastern Suburban League (Div. 2, Sec. A) Shield and medals. Of the 20 games played 16 were won, 1 drawn and 3 lost, scoring 58 goals (with 18 against). Four friendly matches were also played, 3 of which were won and the remaining game drawn, with a goal record of 18 for and 2 against.

The Societe des Ingenieurs Civils de France is organising, for the British Section, a tour in France embracing Paris and the North Eastern part of the devastated regions and including visits to the mines and factories of this area, to take place towards the end of June. The official time-table covers the period from Tuesday evening, June 22 to Friday night, June 25. Details will be furnished on application to the Honorary Secretary, 45, Great Marlborough-street. W.

It is announced that the Radio Corporation of New York has purchased about 6,000 acres of land at Rocky Point, Long Island, for the erection of what will be the LARGEST WIRELESS STATION in the world. It will cost $20,000,000, and will be able to communicate with France, Italy, Poland, Scandinavia, Germany and Argentina. The wireless station at Nauen is the biggest now operating; the one at Bordeaux, with eight towers 800 ft. high, will surpass it, but Rocky Point will far surpass Bordeaux.

Messrs. Benn Brothers, Limited, have purchased from the proprietor (Mr. J. G. Purcell) the goodwill and copyright of the monthly publication known as "The Leather Goods Recorder." This valuable trade paper was established about a year ago to promote the interests of the important leather and fancy goods trade which, since the war, has drifted very largely into English hands. "The Leather Goods Recorder" will be continued as a section of "The Export World and Commercial Intelligence," and will thus exercise a powerful influence upon the development of the English leather and fancy goods trade abroad. There is a tremendous demand at present—a demand which is likely to last—owing to the total cessation during the war of the German fancy goods business and the disinclination of the Colonial and foreign markets to resume business connections with Central Europe.

Personal and Appointments.

Messrs. Pooley & Austin, engineers and manufacturers, of 34, Broadway, Westminster, S.W.1, have taken Mr. W. L. Wreford into partnership.

Mr. Walter T. Young, traffic superintendent of the Edinburgh Corporation Tramways, has been appointed manager of the Dundee Corporation Tramways, at a commencing salary of £600. In addition to Mr. Young, Mr. S. Morrison of Glasgow, and Mr. J. H. Menzies of Dundee, were also interviewed by the Tramways Committee.

Leeds University Council have instituted a Chair of Physical Chemistry and Dr. H. M. Dawson has been selected to be the first occupant of the Chair. Dr. Dawson's connection with the University goes back to the days of the Yorkshire College, at which he was a student of Chemistry. After nomination to the 1851 Exhibition Scholarship and devoting three years abroad to the special study of physical chemistry, Dr. Dawson became a member of the staff of the chemical department at Leeds. Since 1905 he has been lecturer in physical chemistry and has carried out researches in various branches of physical chemistry, particularly in investigations bearing on the constitution of solutions and on the mechanism of chemical change.

Mr. E. G. Phillips, M.I.E.E., A.M.I.Mech.E., who for the last twelve years has been chief engineer to Messrs. Boots, of Nottingham, has resigned that position and opened offices at Queen's-chambers, King-street, Nottingham, as a consulting engineer. Mr. Phillips proposes to specialise in power plants working against back pressures and utilising the exhaust for "process" work. Pneumatic conveying of materials (suction and injection) is also work on which much time has been spent, and which Mr. Phillips hopes to develop considerably. On Friday evening last, at the Island-street works of Messrs. Boots, over 100 of the power house staff and engineering department presented Mr. Phillips with a handsome secretarial desk. Mr. T. S. Ratcliffe, general manager, made the presentation, and Mr. H. B. Clarke, chief technical assistant, paid a high tribute to the esteem and appreciation that all had for their chief.

Tenders Invited.

EDINBURGH Corporation require tenders by June 19, for e.h.t. and l.t. switchgear, &c., for their Portobello station. Specifications from the Engineer.

SALFORD Corporation require tenders by 10 a.m., June 5, for 12 months' supply of a.c. and d.c. meters. Specifications, &c., from the Borough Electrical Engineer.

SYDNEY (N.S.W.) require tenders by 3 p.m., July 19, for the supply of maximum demand indicators. Specifications from the Electric Lighting Department, Town Hall, Sydney.

BETHNAL GREEN (London) Council require tenders by noon, June 7, for two 500 k.v.a. transformers, e.h.t. and l.t. panels, l.t. feeder cables, &c. Specifications from the Town Clerk.

JOHANNESBURG (Transvaal) Corporation want tenders by noon, June 9, for the supply of Electric Runabouts (contract 609), and by noon, June 28, for Electricity Meters and Time Switches (contract 611).

INVERCARGILL (N.Z.) Corporation want tenders by June 22 for a 300 kw. rotary converter. Specification can be seen at the Department of Overseas Trade, 73, Basinghall-street, London, E.C.2.

LONDON County Council require tenders by 4 p.m. June 7 for about 5,500 tons of steel tram rails, guard rails, fastenings, &c. Specification, &c., from the Engineer, County Hall, Spring Gardens, S.W.

LONDON County Council require tenders by noon, June 15, for 4,000 driving and 3,500 trailing wheel tyres. Forms of tender from the Manager, L.C.C. Tramways, 23, Belvedere-road, S.E. 1.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by June 30 for the supply of reactances and condensers for power signalling. Specification from the Commissioner's Offices, Spencer-street, Melbourne.

RHONDDA Education Committee require tenders by noon, June 15, for wiring their Porth, Tonypandy and Pentre secondary schools (about 489 points). Specifications from Mr. J. M. Bowman, Electricity Works, Porth, Glam.

BARNES Urban Council require tenders by noon, June 7, for coal handling plant and overhead steel or ferro-concrete bunkers. Specification from the Engineer and Manager, Electricity Works, High-street, Mortlake, London, S.W. 14.

Tenders are required by noon, June 23, for Telegraph and Telephone Material (schedule 541) for the AUSTRALIAN POSTMASTER-GENERAL'S DEPT., Adelaide. Patterns may be seen at the office of the Controller of Stores in the several States.

INCE-IN-MAKERFIELD Urban Council require tenders by June 15, for (1) two electric motor-driven turbine vertical duplicate pumping sets; (2) two horizontal ditto; (3) cables; (4) conversion of winding engine to electric drive; (5) switchgear. Specifications from the Clerk.

The NEW ZEALAND PUBLIC WORKS DEPARTMENT, Wellington, require tenders by June 30 for supply of 4,300 H.P. water turbine and 3,000 kw. generator (sections 79 & 80) for the Lake Coleridge scheme. Specifications from the Public Works Offices, Christchurch and Wellington.

MANCHESTER Electricity Committee require tenders by June 4 for 12 months' cable supplies, fuse boxes, transformers, &c., and by June 7 for supply and erection at Barton power station of 33,000 volt and 6,000 volt main switchgear, pressure testing switchgear, &c. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

LEEDS City Council invite tenders for a steam turbine, three-phase alternator and exciter of 1,200 kw. capacity or thereabouts. Specifications from the manager of the electricity department, Mr. C. Nelson Hefford, 1, Whitehall-road, Leeds, and tenders to the Town Clerk, 25, Great George-street, Leeds, by 11 a.m. June 14

DUBLIN Electricity Committee want tenders by noon, June 7, for one year's supply of Single and Three-phase Meters. Specification from the City Electrical Engineer, Fleet street, Dublin.

DUBLIN Electricity Department also want tenders by noon, June 1, for d.-c. magazine flame arc lamps. Forms from the Engineer.

HACKNEY (London) Borough Council invite tenders for four water tube boilers, induced draught plants and fuel economisers, one 10,000 kw. turbo-alternator and exciter, surface condensing plant, two circulating motor driven pumps, E.H.T. switchgear, &c. Specifications from the borough electrical engineer, and tenders (by 7 p.m., June 9) to the Chairman of the Electricity Committee.

Tenders are invited (by June 16) for the supply to the Postmaster General's Department, State of WESTERN AUSTRALIA, of telegraph and telephone instruments and parts as per schedule 680, and also (by July 14) for the supply and delivery of telegraph and telephone instruments, &c., as per schedule 674. Tender forms, &c., from the office of the High Commissioner, Room 406, Australia House, Strand, London, W.C.2.

Bankruptcies and Liquidations.

The Signal Electric Company, Ltd., is being wound up voluntarily, and Mr. Winn has been appointed liquidator.

Claims against Jas. Wm. Lewsley, electrician, lately trading at 103, Mansfield-road, Nottingham, are to be sent by June 5 to Mr. E. W. Humphreys, 4, Castle-place, Park street, Nottingham.

The discharge of Fredk. Mitchell, electrical engineer, formerly trading with John Mitchell as Fred Mitchell & Co., at 97, Stockport-road, Ardwick, Manchester, and 58, Ashton Old-road, Openshaw, Manchester, is suspended for two years, ending April 27, 1922.

Patent Record.

APPLICATIONS FOR PATENTS.

NOTE.—*Names within parentheses are those of communicators of inventions.*

December 31, 1919.

32,729 AUTOMATIC TELEPHONE MFG. CO. & H[illegible]. Electro-magnetic mechanism for [illegible].
32,7[illegible]2 H. M[illegible] L[illegible] & WEST[illegible]. Control of crane hook motions actuated by alternating-current motors.
32,753 MAL[illegible] P[illegible]. Electric fans and lights.
32,76[illegible] L[illegible]. E[illegible] for oxidising nitrogen.
32,764 L[illegible]. A[illegible] electrical conductivity of metals.
32,767 AVERY & F[illegible]. Cut-out.
32,77[illegible] FIELD. Means for measuring electric currents.
32,78[illegible] VAN RA[illegible]EN & CO. & RANKIN. Electric generators and motors.
32,787 LEVIN. Ind[illegible] for electrolytic cells.
32,79[illegible] LEVIN. Separators for cells.
32,791 LEVIN. Electrolytic cells.
32,792 LEVIN. Feeding attachments for electrolytic cells.
32,793 LEVIN. Electrodes.
32,794 LEVIN. Electrolytic apparatus.
32,812 ROBINSON, CROWTHER & ERSKINE MURRAY. Radio-navigational apparatus, &c.
32,8[illegible]0 B. T.-H. CO. (G. E. Co.). Radio-receiving systems.
32,845 NAAMZ[illegible] VE[illegible]RTS ELEKTROTECH INDUSTRIE V[illegible]R (W. Smith & Co.). Fixing insulating rings on shafts, &c. (20/2/12. Holland.)
32,879 QUAIN ELECTRIC CO. & SPINK. Electric cigar lighters, &c.

January 2, 1920.

52 G. E. CO. & D[illegible]LE. Enclosed bulb electric devices.
64 CAYROL & O[illegible]N. Battery. (25/4/14. France.)
66 B[illegible]LTEMANN. Manufacture of insulating material. (29/1/18. Germany.)
44 LACKIE. Recording meter.
103 REMARTINI. Electric air heating devices.
128 TAYLOR. Electric distribution with alternating currents.
151 B.T.-H. CO. (G E. Co.) Signalling systems.
152 B.T.-H. CO., CL[illegible]GH, H[illegible]TT & TAYLOR. Dynamo-electric machines.
161 JEAL. Means for starting internal combustion engines and for generating electric current.
170 VANDERVELL & MIDGLEY. Electric machines.
181 METROPOLITAN-VICKERS ELECTRICAL CO. Packing and clearance strips, &c.
190 STERLING TELEPHONE & ELECTRIC CO. Indicators or communicators.

January 3, 1920.

209 AUTOMATIC TELEPHONE MFG. CO. Arrangement for offering greater impedance to direct current than to alternating current.
226 C[illegible]AN. Electric kettles, &c.
244 B.T.-H. CO. & TAYLOR. Controlling devices for alternating-current machines.
254 RADIO COMMUNICATION CO. & BENYON. Electric oscillation arcs.
264 BUCKHAM & DAWSON. Switches.

January 5, 1920.

313 & 314 CONRADI. Apparatus for controlling electric currents.
315 METROPOLITAN-VICKERS ELECTRICAL CO. Valve-operating gear.
347 REES. Inductances for wireless telegraphy and telephony.
358 DOMESTIC ENGINEERING CO. Electrical systems. (6/4/18, U.S.)
363 MELLERSH-JACKSON. (Allen Electrolytic Cell Corpn.) Electrolytic cells.
372 HAUSSER-STAUB. Electric heaters. (8/8/19. Switzerland.)

January 6, 1920.

386 BOOTH. Anti-vibrators for incandescent lamps.
426 BROWNE. Electrically-operated lawn mower, &c.
444 REEPMAKER D'ORVILLE. Electrically-controlled combustion system.
452 ARMSTRONG. Electrically-heated cooking device. (27/6/16, U.S.)
467 GREEN. Accumulators.

January 7, 1920.

500 SCOTT'S SHIPBUILDING & ENGINEERING CO. & CAPARN. Magnetic clutches.
502 CAPARN. Limit switches.
520 LAVIN & SMITH. (Automatic Electric Co., partly.) Dial switches for automatic telephone systems.
534 DARBY. Device for locating leakages or short circuits on or between electrical conductors.
542 ILG ELECTRIC VENTILATING CO. Units for heating and ventilating systems. (9/1/18. U.S.)
549 QUASI ARC CO. & STROHMENGER. Electrodes for welding or fusion deposition.
579 IMRAY. (Eisemann Magneto Corpn.) Magnetic with oscillating armatures.

January 8, 1920.

602 TAYLOR. Electric power generation and transmission with alternating currents.
615 BROWN & DAVIES. Means for making and breaking electrical circuits.
638 ALLISON. (Narabayashi.) Filling for storage batteries.
654 COWPER-COLES. Zinc battery elements.
673 B.T.-H. CO. & TAYLOR. Ventilation of electrical machines.
675 B.T.-H. CO. (G.E. Co.) Electric heating units.
695 CALVERT. Incandescent lamps.
697 WARD. Generation of electricity by rise and fall of tides.
707 METROPOLITAN-VICKERS ELECTRICAL CO., COATES, DAVIES & GITTINS. Switchgear.
710 BOOTH ELECTRIC FURNACE CO. Furnace doors. (4/4/18. U.S.)

January 9, 1920.

716 MOLESWORTH. Automatic train stop and track circuit signalling.
729 AUTOMATIC TELEPHONE MFG. CO. & REMINGTON. Mine signalling systems.
730 SIMPSON. Electric circuit breaker.
736 TAYLOR. Generating and transmitting alternating currents.
752 BENTLEY & SCOTT. Electric cranes, hoists, &c.
761 STRANG. Adapters for electrical connections.
766 KNIGHT. Telephone transmitters.
775 NE[illegible]MANTI. Electrically heated garments.
782 G[illegible]WEN. Incandescent lamps.
788 WIL[illegible]. Supporting electric fuses in operative position.
793 FAVRE-BULLE & MOULIN. Electro-magnetic clocks.
809 N[illegible]TTAGE & PARKIN. Wireless telegraph calling devices.
811 WADE. (Booth Electric Furnace Co.) Electric furnaces.

January 10, 1920.

877 WILSON. Electric welding.
878 JEFFERSON. Electric plug connecting appliances.
879 ELECTRIC HEATING & HARDWARE, LTD., & WINEBERG. Electric heating device.
886 GRAY. (Electric Vacuum Cleaner Co.) Suction cleaner.
887 B.T.-H. CO. (G.E. Co.) Electrical apparatus.

January 12, 1920.

932 LAWTON & MARSTON. Electric generators for automobile-lighting sets.
948 BEAVAN. Electric heaters.
968 BUTLER. Electric plug connection.
974 B.T.-H. CO. (G.E. Co.) Electron discharge devices.
1,003 ADAMS. Trip mechanism for electric ignition for engines.
1,007 FURNIVAL & VAN DE VELDE. Wireless direction finding means for aircraft.
1,017 DICKINSON. Charging accumulators.
1,[illegible]25 OLDHAM. Galvanic batteries.

January 13, 1920.

1,050 THOMPSON. Utilising power of sea for generating electricity.
1,079 SIMPSON. Electric lamps.
1,086 EDISON SWAN ELECTRIC CO. & CAINE. Electrical connections.
1,089 KING. Dry battery.
1,101 MURPHY. Wireless direction finding systems.
1,134 WHITE. (Toledo Standard Commutator Co.) Commutators for electrical machines.

Companies' Reports, &c.

The directors of the Edison Swan Electric Company, Ltd., have prepared a scheme for increasing the borrowing powers of the Company.

The agreement for the transfer of the Spanish & General Wireless Trust, Ltd., to the Spanish & General Corporation, Ltd., has been executed.

The Oldham, Ashton and Hyde Electric Tramway, Ltd., has declared a dividend of 8 2-5d. per share on the ordinary shares, making 6 per cent. for the year.

The directors of the Nairobi Electric Power & Lighting Company, Ltd., have declared a final interim dividend of 2 per cent. for 1919, making 10 per cent. for the year.

The directors of S. Smith & Sons (Motor Accessories), Ltd., have declared an interim dividend at the rate of 7½ per cent. per annum on the ordinary shares for the half-year.

The directors of the Chloride Electrical Storage Company, Ltd., have declared a final dividend for the year ended March 31 of 1s. 4d. per share (tax free) on the ordinary (against 1s. per share in 1919). An interim dividend of 1s. per share was paid in December.

The report of the Anglo-American Telegraph Company, Ltd., for the year ended March 31 states that the three quarterly interim dividends and the final dividend for the year, paid in January last, absorbed £262,500. being rent paid by Western Union Telegraph Company for year. These dividends equalled 3¾ per cent. on the ordinary, 6 per cent. on the preferred, and 1½ per cent. on the deferred. Balance at credit of revenue account (£68,822) includes £3,197 interest received, and £65,625 is available for payment of dividends for quarter ended March 31

The net profit of Babcock & Wilcox, Ltd., during 1919 was £455,089. Adding £92,089 from 1918, and deducting the interim dividends paid in October of 3 per cent. on the preference, 2½ per cent. on the second preference and 6 per cent. on the ordinary shares (£107,076), the balance is £440,102. The directors recommend that the following dividends be paid for the half-year ending Dec. 31, 1919. viz., 3 per cent. on the preference and 2½ per cent. on the second preference (less tax), and 9 per cent. on the ordinary shares (tax free), absorbing £156,876, that £150,000 be placed to reserve and £10,000 granted to the staff pension fund, leaving a balance to be carried forward of £123,225. The construction of the works of the Sociedad Espanola de Construcciones Babcock & Wilcox will be completed this year. The company is equipping auxiliary works in Australia and Italy, and extending its Japanese works. The French Babcock & Wilcox Works have been enlarged and the capital of that company increased. At Renfrew considerable extensions are being undertaken ; a new foundry and a new pipe shop are being erected, and the crane making department is being enlarged. New offices are also being erected. At the works in Dumbarton extensions are likewise in progress. The use of the company's marine boilers is increasing, and the orders in hand in all manufactures are satisfactory. Though there is some improvement noticeable in the output of the workmen, it is still below the pre-war standard, and there are also continual interruptions, through trade disputes.

The difficulties of provincial electric supply undertakings were dealt with by Mr. P. D. Tuckett, chairman of the Urban Electric Supply Company, Ltd., at the meeting last week. The conditions under which they had been called upon to conduct the business during the past year had been altogether beyond their control, and, so far as their ability to earn profits was concerned, they might just as well have had its conduct taken out of their hands. They had been entirely at the mercy of the Coal Controller as to both the price and quality of their coal, whilst wages had been continually advancing under the operation of successive awards. As a result the burden of increased costs was now quite overwhelming. Last year, following on an increase of £28,000 in 1918, the higher price of coal and the rise in wages accounted for a further increase of £36,000. making a total increase of £120,600 since 1914 for those two items alone, apart from the heavy increase in rates, taxes, repairs, &c. They had made repeated applications to the Board of Trade to place them in a position to meet those increased costs by sanctioning corresponding increases in rates of charge, but the relief obtained had been wholly inadequate. They were already faced with an additional burden of £52,000 for the current year. The Electricity Commissioners had promised to afford them some relief, but they had not specified the exact form which the remedy would take. The accounts for the year showed a further shrinkage of £4,000 in gross profits, and they were not able to pay the preference dividend or provide sufficient for depreciation.

The effect of the higher wages and the increased cost of coal and other materials upon electric supply undertakings was dealt with by Mr. C. Jermyn Ford, at the meeting of the Altrincham Electric Supply, Ltd., on the 20th inst. The year's profit was £6,913, or within about £200 of the profits for the previous year. They were able to present a more satisfactory report of the results of the operations for the past year than they anticipated six months back, when the profits for the first three quarters of the year fell short of those for the same period in 1918 by about £3,000. The labour conditions at that time promised to extend and prolong the disorganisation to an extent which would still further adversely affect profits, and considerable curtailment of the working hours in the factories which they supplied actually resulted in a decrease of revenue from that source. The cost of labour was steadily increasing, as was the cost of all materials ; and they were in a less fortunate position than some undertakings, because, while they were saddled with a heavy increase in the cost of coal, they had not increased their charges for electrical energy to any but industrial concerns. The recovery of industrial activity was unexpectedly slow, and was hampered to a disastrous extent by strikes, which, in addition to affecting the revenue from existing consumers, delayed the completion of new factories which were being erected in the district, and to which they were already supplying power. The company's supply continued to meet with favour as a manufacturing centre, and the chimney restriction imposed by the Stamford Estate, was obviously of great value to the company. The new 2,000 kw. generator and the Stirling boiler should be ready for use about November next, and, presuming the demand for current continued to increase, as they had every reason to believe it would, they ought to be producing at a considerably lower cost, after taking into account the automatic increase of cost in consequence of the rise in the price of coal. As it was of the greatest importance to pay every regard to economies in the cost of production, they were installing a fuel handling plant.

Lord Ashfield presided over the meeting of the London and Suburban Traction Company, Ltd., and stated that the result of the year's working was disappointing, but when they observed the extent to which the expenses of the operating companies had increased and how little the fares had been advanced, no other result could be expected. The increased revenue of the three tramway companies was more than counter-balanced by the increase in operating expenses. There were, moreover, no signs of any decrease in the price of materials, and further demands were being received for increases in wages. The scheme of reconstruction of the capital of the London United Tramways had been carried through. Dealing with the future, he said that so long as expenses were kept within reasonable limits, the public would pay such fares as would produce a revenue necessary to keep the undertakings in a reasonably prosperous condition. On the other hand, he was certain there was a rate of fare which would secure the maximum earnings, and to go beyond that rate would reduce the earnings and bring disaster to the undertakings. He would, therefore, take that opportunity of warning those who were constantly agitating for increased wages that they could overburden the undertakings and bring disaster to themselves and to all those associated with them. The tramway and omnibus undertakings in which the company was interested were not earning sufficient to meet their actual expenses, and until fares had been increased and it was known definitely just how much the public would pay, and whether sufficient revenue could be obtained to meet even the present expenses, including depreciation and a reasonable return on capital, it was difficult to see how further increases in expenses could be incurred.

During the past year the Calcutta Electric Corporation, Ltd. sold 31,881,710 units of electrical energy, compared with 30,431,132 units in 1918. The number of houses connected at Dec. 31 last was 10,271, against 9,897. The profits amount to £237,207, which, with balance from 1918 and interest on money at deposit, &c., makes a total of £298,460. After deducting the interim dividend of 4 per cent. on the ordinary shares, the dividends on the preference shares, the sum of £34,408 placed to credit of depreciation and renewals account, the balance of excess profits duty for 1917 and 1918 (£27,724), and an estimated liability of £34,070 for 1919 for similar duty, &c., the available balance is £136,893. The directors recommend that £55,000 be added to reserve, £5,000 to insurance fund and £5,000 to retiring gratuity fund ; that a final dividend be paid on the ordinary shares for the second half-year of 6 per cent. (actual), making 10 per cent. for the year. Further, it is recommened that one fully-paid preference share be issued as a bonus for each 10 ordinary shares held. A balance estimated at £45,693 will be carried forward, after providing for the directors' additional remuneration of £4,000. The expenditure on capital account last year amounted to £51,654, the total outlay to date being £1,438,009. The demand for electrical energy continues to increase and satisfactory progress has been made. Additional capital is required, and the board therefore recommend that the capital be increased, and that the interest on the preference shares be increased from 5 to 6½ per cent. The company's agent and chief engineer (Mr. R. E. Winkfield) has retired after 15 years' service, and the deputy agent (Mr. J. T. Mertens) succeeds him.

New Companies.

BRITISH ZINC PRODUCTS, LTD. (166,842.)—Private company ; reg. April 27, capital £25,000 in £1 shares, to carry on the business indicated by the title, and that of smelters, refiners, dealers in metals, &c. First directors are F. Jones, H. W. Lloyd and T. R. Jones. Secretary, T. Mills, Reg. office, Pipe House Wharf, Swansea.

H. A. BRYCE, LTD. (167,372)—Private company. Reg. May 12, capital £5,000 in £1 shares, to take over the business of an electrical engineer carried on by Herbert A. Bryce. First directors are H. A. Bryce, J. Enock and J. R. Marsh. Reg. office : 69, Middlewood-road, Hillsbrough, Sheffield.

T. EMERY'S AUTOMATIC POWER GENERATING MOTORS, LTD. (167,337)—Reg. May 11, capital £10,000 in 5,000 preference shares of £1 each and 100,000 founders' shares of 1s. each, to take over from T. Emery certain inventions and patent rights, and to carry on the business of manufacturers and self-starting automatic power generating motors for power stations and factories, &c. Permanent directors are Dmitri Tchernine, W. T. C. Lock and T. Emery (man. and technical). Reg. office : 392, Strand, W.C.

LESTER & BROWNE (LONDON), LTD. (167,288)—Private company. Reg. May 10, capital £5,000 in £1 shares, to carry on the business of manufacturers of and dealers in electrical accessories and appliances, electrical and general engineers, &c. First directors are G. W. Lester, G. E. Lea Wynne and E. H. Bonney. Reg. office : 44 and 46, Surbiton-road, Kingston.

PREMIER ELECTRIC WELDING COMPANY (IRELAND) LTD. (3,963.)—Private: reg. in Dublin April 20, capital £10,000 in £1 shares, to acquire the business carried on at Belfast by K. Edwards as the "Premier Electric Welding Company."

STANLEY GAYNER & COMPANY, LTD. (166,855.)—Private company; reg. April 27, capital £3,000 in 2,500 shares of £1 each and 10,000 shares of 1s. each, to carry on the business of electrical engineers, motor and aeroplane manufacturers, &c. Reg. office, Park-lane, Queen-street, Cardiff.

WARDLEY SMITH, LTD. (167,154)—Private company. Reg. May 5, capital £2,000 in £1 shares, to take over the business carried on at Rochdale as Wardley Smith, and to carry on the business of electricians, mechanical engineers and manufacturers, switchgear manufacturers, &c. First directors are W. J. B. Ward, E. Brierley and E. Smith.

WATSON-NORIE, LTD. (166,962.)—Private company; reg. April 30 capital £8,000 in £1 shares, to take over the business carried on at Back Park-road and Clyde-street, Wallsend-on-Tyne, as "Watson-Norie," and to carry on the business of electricians, electrical and structural engineers, &c. Reg. offices, 42, High-street, Wallsend.

Forty Years Ago.

(The Electrician, May 29, 1880.)

Cable to Bermuda.—The scheme of laying a cable from Halifax to Bermuda is being agitated by various members of the Canadian Parliament, as well as by certain prominent business men. It is believed that England ought to have a cable between those points for the accommodation of the naval department and for the purpose of trade and private use.

An Important Telegraphic Invention.—Charles C. Buell, of New Haven, and formerly of this city, has invented a self-adjusting relay magnet, which is in practical operation in the American Union Telegraph Offices at New Haven. The Page patent, owned by the Western Union Company covers the employment of a retractile spring, or its mechanical equivalent, in the adjustment of relay magnets, but this invention avoids the Page patent, with as good results and less costly instruments, and is pronounced by electricians to surpass Edison's Electro-motograph, designed for the same object.

Electrical Insects.—"You are well acquainted with the history and properties of the *Raia Torpedo* and *Gymnotus electricus*; but, I dare aver, have no idea that any *insect* possesses their extraordinary powers. Yet I can assure you, upon good authority, that *Reduvius serratus*, commonly known in the West Indies by the name of the *wheel bug*, can, like them, communicate an electric shock to the person whose flesh it touches. The late Major-General Davis, of the Royal Artillery, well known as a most accurate observer of nature, and an indefatigable collector of her treasures, as well as a most admirable painter of them, once informed me that, when abroad, having taken up this animal and placed it upon his hand, it gave him a considerable shock, as if from an electric jar, with its legs, which he felt as high as his shoulder; and, dropping the creature, he observed six marks upon his hand where the six feet had stood. Two similar instances of effects of the human system resembling electric shocks, produced by insects, have been communicated to the Entomological Society by Mr. Yarrell: one, mentioned in a letter from Lady de Grey, of Groby, in which the shock was caused by a beetle, one of the common *Elateridæ*, and extended from the hand to the elbow on suddenly touching the insect; the other caused by a large hairy lepidopterous caterpillar, picked up in South America by Capt. Blakeney, R.N., who felt, on touching it, a sensation extending up his arm, similar to an electric shock, of such force that he lost the use of his arm for a time, and his life was even considered in danger by his medical attendant."—*Kirby & Spence's Entomology.*

Postal Telegraphs.—The estimate for the year ending March 31, 1881, is £1,210,736 against £1,115,195 for the past year, that is an increase of £95,541. It is probable that this extra money shows the cost of the erection of the main line to be built to the north.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics":—"Air Mails for Britain" and "Micarta Propeller Tests."

"Cabinet Maker":—"Work of the Advisory Committee for the Cane Basket and Willow Industry"; "Trade Schools in France: The Training of Apprentices"; "Two-Legged Tables."

"Chemical Age":—"German State Electro-Chemical Industries"; "A Year's Progress in British Dyestuffs Organisation"; and "Notes on the Chilean Nitrate Industry."

"Fruit-Grower":—"National Federation of Retail Fruiterers' Conference": "Economic Value of Hawks and Owls"; and "The Cultivators' Charter."

"Gas World":—"Government Gas Regulation Bill"; "The Production of Benzole"; "Inventions for the Manufacture of Neutral Sulphate of Ammonia."

"Hardware Trade Journal":—"Aluminium and Nickelwares"; "Benches for Metal Workers"; and "The Oil Hardening of Screw Gauges."

"Ways and Means":—"The Human Element in Industry," by Kenneth Lee; "Housing: Who is to Pay?" by John Baker; "Is Labour Better Off?" by Miss Violet Ralph.

Arrangements for the Week.

FRIDAY, May 28th (to-day).

Royal Society of Arts.—Indian Section.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Lignite," by Prof. W. A. Bone, F.R.S.

Physical Society.

5 p.m. At the Imperial College of Science, Imperial Institute-road, S. Kensington, London, S.W. Discussion on "X-Ray Spectra," to be opened by Sir W. H. Bragg, F.R.S.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette: "Two Years as an Engineer in the Grand Fleet," by Mr. A. Arnold.

7.30 p.m. At the Lecture Hall, Public Library, Plymouth. Inaugural Meeting of South Western Local Section.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "Crystal Structure," by Prof. W. L. Bragg, M.A. (Lecture I.).

SATURDAY, May 29th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Tyndall Lecture on "The Theory of Relativity," by Dr. J. H. Jeans, F.R.S.

TUESDAY, June 1st.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "The Evolution of Large Bridge Construction," by Major C. E. Inglis, O.B.E. (Lecture II.).

THURSDAY, June 3rd.

Royal Society.

4.30 p.m. At Burlington House, Piccadilly, London, W. Bakerian Lecture on "The Nuclear Constitution of the Atom," by Sir Ernest Rutherford, F.R.S.

FRIDAY, June 4th.

Royal Society of Arts.—Indian and Colonial Sections.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "The Oil Resources of the British Empire," by Prof. Sir John Cadman, K.C.M.G.

Prices of Metals, Chemicals, &c.

Tuesday, May 25.

		Price.	Inc.	Dec.
***Copper*—**				
Best selected.........	per ton	£109 0 0	—	£3 0 0
Electro Wirebars...	,,	£109 0 0	—	£5 0 0
H.C. wire basis......	per lb.	1s. 3¾d.	—	—
Sheet	,,	1s. 5½d.	—	—
***Phosphor-bronze Wire*—**				
Phosphor-bronze wire, basis	,,	1s. 8¾d.	—	—
***Brass* 60/40—**				
Rod, basis	,,	0s. 11½d.	—	—
Sheet, basis	,,	1s. 4¼d.	—	—
Wire, basis	,,	1s. 3¾d.	—	—
***Iron*—**				
Cleveland Warrants	per ton	£11 17 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£48 10 0	—	—
***Lead Pig*—**				
English	,,	£41 10 0	—	£1 10 0
Foreign or colonial	,,	39 15 0	—	£0 10 0
***Tin*—Ingot ....**	,,	270 0 0	—	£27 0 0
Wire, basis	per lb.	0 3 7½	—	—

***Salammoniac.*—Per cwt. 105s.–100s.**

***Sulphur* (Flowers).—Per ton £19.**

,, (Roll Brimstone).—Per ton £19.

***Sulphuric Acid* (Pyrites, 168°).—Per ton, £8 8s. 9d.**

***Copper Sulphate.*—Per ton £46.**

***Boric Acid* (Crystals).—Per ton £74.**

***Carbon Bisulphide.*—Per ton £60.**

***Sodium Bichromate.*—Per lb. 1s. 11d.**

***Sodium Chlorate*—Per lb. 5½d.**

***Rubber.*—Para fine, 2s. 2d.; plantation 1st. latex 1s. 11½d. to 1s. 11¾d. per lb.**

***Shellac.*—T.N. Orange, 590s. to 600s.**

The Editorial, Advertisement and Publishing Offices of "The Electrician" *are at 8, Bouverie Street, London, E.C.4. Telegrams: Benbrotric, Fleet, London. Telephone: City* 9853 *(4 lines).*

The subscription to "The Electrician" *is* £2. 12. 0. *per annum in the United Kingdom, and* £2. 14. 0. *per annum Abroad. Advertisement Rates can be obtained on application to the Manager. Advertisement copy and blocks should be received on the Friday preceding date of publication.*

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING. INDUSTRY. SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,194. [Vol. Nr. 23. LXXXIV.] FRIDAY, JUNE 4, 1920. PRICE ONE SHILLING. *By Post*, 1s. 1d. *Abroad* 1s. 2d.

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Notes.

Commercial Electrical Osmosis.

THE phenomenon of osmosis, first discovered by GRAHAM in 1851, has for many years been considered of greater theoretical than practical interest. The development by PICTON and LINDEN of the methods employed to collect the substances in colloidal suspension by the use of an electric current, however, widened the field of the investigation, and gave rise to some further interesting results: but, as pointed out by Messrs. J. S. HIGHFIELD, W. R. ORMANDY and D. NORTHALL-LAURIE, in a Paper read at a recent meeting of the Royal Society of Arts, it has been left for recent experimenters, including notably SCHWERIN, to show the industrial uses to which this phenomenon can be put. It forms, indeed, yet another example of the fact that there is no discovery of so theoretical a character that may not eventually find some practical application.

The Purification of Clay.

THE particular industrial application of electrical osmosis with which the authors deal is the purification of clay. A tank of suitable form is employed, in which the impure clay is kept in agitation by paddles fixed in the lower portion. Directly above the paddles is the cathode, through holes in which the clay in suspension is passed. In so passing it becomes negatively charged, and is attracted to the anode. The effect is that a dry layer of pure clay is deposited on the anode, while the electro-osmotically indifferent particles are freed from it and are washed away by the effluent from the machine. The clay leaves the anode in the form of a blanket from one quarter to one-half inch in thickness, and in a form which can easily be used; this in itself being a distinct advance over the earlier processes. The product is pure, and allows chemical porcelain of the finest quality to be produced; with it vitrification takes place at a lower temperature than in raw clay, so that clays produced by this means can be finished at a lower temperature and reduced fuel consumption than is now usually possible. The process, indeed, opens up a wide and interesting field, and the commercial results obtainable should be highly satisfactory, if properly managed. We shall watch the progress made with interest.

Central Station Salaries.

THERE is matter for congratulation in the agreément which has been reached by the National Joint Board of Employers and Staffs for the Electric Supply Industry on the conditions of employment and salaries for technical engineers. Much of the work of the subordinate technical staff in an electricity supply undertaking is arduous and uninteresting. But it is work which requires that the supervisory and assistant supervisory positions should be held by men possessing considerable technical knowledge, and it is only right therefore that that knowledge should be adequately paid for. Unfortunately for those concerned the supply of trained men for these posts has always exceeded the demand. The result is that for every vacancy there is a plethora of applicants and, human nature being what it is, this in itself has been an obstacle to the adjustment of undoubted grievances. It is a state of things which is bad, because it breeds discontent. We are glad, therefore, that it is altered by the new arrangement which at least assures to all grades a fairly adequate basic wage and, what is more important, prevents that unfairest form of competition which allows applicants to compete among themselves by a species of secret Dutch auction in which the post goes to the lowest bidder.

Standardisation or Stultification.

BUT there is always one disadvantage about such agreements; and it is a disadvantage which becomes graver the greater the skill and knowledge of the employee concerned. For while a Trade Union is probably pursuing the right policy in ensuring for its members a fixed scale of wages now that modern conditions of manufacture demand no high degree of manual skill from the majority of workers, and all are therefore brought nearer to one dead level, it is equally certain that an Association of Technical Workers is wrong in following this course. A man in a position of responsibility is paid a certain salary not because he holds that position but because his knowledge, and above all his personality, make it worth his employers to pay him that amount. To such a man grading and basic salaries and all that they imply are rather a hindrance than a help, because he knows his own value and can therefore do better for himself alone than in combination. We hope the Electrical Power Engineers' Association, for whose aims and objects we have the greatest sympathy, will bear this point in mind. It would be a great pity if knowledge and enterprise were in any way stultified by their well meaning efforts to improve their status.

Arbitration and Arbitrariness.

Further trouble in the electricity supply world has occurred, this time at Wimbledon, and at present the position is grave. As we mentioned last week, the National Joint Council recommended that the bonus of £90 now paid to members of the E.P.E.A. working in the station should be increased to £120 per annum. This recommendation, though accepted by the Electricity Committee, was refused by the Finance Committee, whose attitude was supported by the Town Council. The arguments for and against the increase have, no doubt, been exhaustively discussed; but in a case like this they are of small importance compared with the high-handed way in which the decision arrived at by the National Council has been set on one side. These Councils have great power for good, but that power can only be exercised if their decisions are loyally accepted by both parties. At present there is a regrettable tendency on the part of some municipal authorities only to accept these decisions when they are in their favour. It is a procedure of which trade unions are accused, often unjustly, but it is highly unsatisfactory that it should be adopted by those who are supposed to represent the public interest.

The Association of Consulting Engineers.

The annual dinner of the Association of Consulting Engineers last week reminded us that consulting engineers are now getting back to that normal state of activity which was so greatly interrupted by the war. There is no doubt that the Association has justified its existence. At the dinner, Mr. A. H. Dykes, the Honorary Secretary, gave a humorous account of a mill owner in 1908 who, owing to the general ignorance of what a consultant is and where he may be found, sought in vain for many weeks to find a consulting engineer. Even now, notwithstanding the work of the Association, this ignorance is still very general. It may be doubted, for example, whether any Government Department would not be equally at sea with the mill owner of 1908. Had it not been so we should have thought that during the war much useful work would have been found for consulting engineers in supervising contracts, whereas the Government preferred to carry out work on the basis of cost of labour and materials plus a percentage, a method that led to enormous waste and needlessly increased the cost as the present abnormal taxation sufficiently indicates. The consulting engineer is able to bring to his work not only an expert knowledge but a detached interest of which Government departments, municipalities and other large concerns would do well to make full use.

Negotiating with Labour.

Those who attended the dinner of the Association of Consulting Engineers had the advantage of hearing Lord Cowdray on various matters on which he is essentially qualified to speak. Lord Cowdray remarked on the foolishness of dealing with Labour in sections. This is a point which is continually forgotten. The dockers, for example, put forward a claim for 16s. per day. The case was heard, as is usual on these occasions, by a Committee which was largely unfamiliar with industry, and therefore looked upon the whole matter with a philanthropic eye, instead of considering what was practicable. The tacit assumption was made that any advance given to the dockers would affect the dockers alone. Unfortunately, however, this assumption is entirely wrong, as will soon be abundantly clear, for, now that the dockers have gained higher wages, the railwaymen are also asking for more, not because the cost of living has increased, but because, as Mr. Cramp says, "with the workers, a man's standing is almost entirely related to his income; men, women and their children are judged and their social conditions are determined by the amount of wages or salary which they are able to earn, and the consequent standard of life they are able to maintain." A good reason, but hardly good enough for the country, for, if the railwaymen receive an advance, the miners will certainly put in a claim, and after this is settled it will be time for the dockers to start once more in order that the relative grades in labour may be maintained in accordance with the new scale of social status. If for no other reason, it is high time that this sectional method of giving advances came to an end.

The Non-Ferrous Mining Industry.

Our attention is often so forcibly called to conditions in the coal mining industry, and as engineers we are so intimately connected with the iron and steel industry, that we are apt to forget the quite as important, though smaller branches of mining activities conveniently included under the term non-ferrous. Nevertheless, this is one of the oldest, if not the oldest, of this country's industries, and at a time when the development of our resources is of the highest importance it is well that attention should be paid to its organisation and development. The Departmental Committee which has recently been inquiring into these questions has now issued its report, which includes some interesting recommendations. Among them are proposals to centralise the various duties relating to the mining of minerals other than coal in one organisation which would become a sub-department of the Mining Department, and to expand the Mineral Resources Development Branch of the Board of Trade by including within it mining engineers and mining geologists with expert knowledge of non-ferrous matters. Such debatable questions as leases and wayleaves would also come within the scope of the new Department, while the funds at the disposal of the Development Commissioners would be available for assisting mining companies to tide over any temporary difficulties. While we are not disposed to look favourably on further encroachment of Government influence into industry, there are cases where the national resources can be usefully employed, and this seems to be one of them. We also welcome the proposal to purchase the blende production of the zinc mines of this country at a price which will enable them to compete with Australian concentrates, and the idea of encouraging students to enter the mining industry by the establishment of scholarships. We hope that early effect will be given to the recommendations, and that great developments will result.

Defects in Electro-Deposited Iron.

As is well known, electro-deposited iron has lately been employed to a large extent for "building up" worn and under gauge parts on aeroplanes and guns. For such work it can be of great value, but it is important that properties which it does not possess should not be ascribed to it, and its defects should be quickly discovered so that they may not prevent future development. In examining with the microscope iron that has been deposited under various conditions of correct density and temperature and from various solutions, Mr. W. E. Hughes has done useful work, for, as he points out in a Paper read before the Iron and Steel Institute, the matter is of much importance to engineers. The defects, though they may render the use of electrolytic iron dangerous, can fortunately be eliminated by efficient control of the deposition process. Electrolytic iron is often far from pure and is not necessarily hard or brittle. The experimental results contradict certain easy but widely held suppositions. Mr. HUGHES' argument put shortly is that there is a great future for electrolytic iron if better methods than those at present employed are used. With that conclusion we cordially agree.

Some Practical Details.

SOME further interesting details of the processes necessary in carrying out this work were given by Mr. B. H. THOMAS in a Paper recently read before the Institution of Automobile Engineers. Mr. THOMAS rightly lays stress on the importance of cleaning and preparing the work. This is done first by treating with petrol, then boiling for 12 hours in a caustic soda solution, and finally cleaning with scratch brushes. The parts are next made a cathode in a soda bath and an anode in an acid path to erode the surface and give a better interlock for the deposit. The deposition proper is carried out in an ammonium sulphate solution, which is kept as nearly as possible neutral. An anode of Swedish iron wire is used, and care is taken to keep the temperature about 68 deg F. and prevent the solution becoming stagnant. This all goes to show that successful though these processes may be care is necessary in their employment if the subsequent product is to perform efficiently the work required of it.

Portable Cinema Outfits.

THE interesting account given by Captain J. W. BARBER of portable cinematograph outfits before a recent meeting of the Illuminating Engineering Society deserves study. The cinematograph industry has grown to such dimensions that one might expect the design of portable self-contained apparatus to make considerable progress, once certain technical difficulties are overcome. Efforts in this direction in the past have frequently failed, either because the apparatus was too unstable, because it was too complex to manipulate, or because the intensity of light provided was insufficient. Capt. BARBER was able to show no less than four distinct types of portable projectors, all using incandescent electric lights as the source. Two of these were of the travelling "suit case" variety, the light being derived from a focus-type gas-filled lamp run off the electric supply, whence a surprisingly good image was obtained. Another apparatus, which represents the extreme limit of portability, the Pathescope, requires no external source of power, being operated entirely by hand, the manual effort driving a small magneto which feeds a small incandescent lamp. While naturally only intended for a relatively small screen, and thus suited for small rooms, this apparatus gives quite a good picture. The fourth apparatus, stated to be the only one of its kind in the country, had several highly interesting and unique features, being arranged in cabinet form, and the light reflected by a series of mirrors on to a diffusing translucent panel.

A Mobile Apparatus.

A SINGULAR feature is the apparent absence of "works," the whole process taking place automatically and the pictures following in sequence on the screen immediately the current is switched on. Both as regards brightness and definition the results appeared excellent, though here, again, the screen is naturally of small size. While such forms of apparatus are doubtless still capable of improvement, it is evident that considerable progress has been made; and, as the whole problem consists in the proper direction of light, cinema experts may obtain some useful hints from lighting engineers. Another form of cinema projector, which may be described as "mobile" rather than "portable," involves a travelling petrol-driven generator equipment. As is well known, vans carrying cinema apparatus have recently proved an important element in propaganda at home and abroad, and we understand that Capt. BARBER was responsible for the designing the "cinemotors" of this type used by the Ministry of Information and the National War-Aims Committee during the war.

The Tramway Deadlock.

FOR the past month there have been discussions, conferences, meetings and informal conversations galore, but so far nothing like agreement has been come to in the tramways wages dispute. Indeed, matters have become worse rather than improved, and have reached that uncomfortable state known as a deadlock, when both sides stand stiffly upon their respective dignities, and irritability rather than conciliation is in the ascendant. The Ministry of Labour has now concerned itself in the matter, and the National Joint Industrial Council met last Wednesday under the chairmanship of Sir DAVID SHACKLETON, but no result has yet been obtained. We confess we are not optimistic, for the simple reason that the men either cannot or will not realise that many of the tramway undertakings cannot afford to make the increase, as to do so would turn the present slender profits into a loss, and that no commercial undertaking can carry on under those conditions, whatever a Government Department may do. In spite of this, however, agreement has been reached in all districts but four, of which one is London, where it is considered that preferential treatment should be given; in Scotland, the south-western district, and Yorkshire, which apparently consider they have been unfairly treated when compared with Lancashire. It is yet another example of the fact that economics, value for service rendered, justice and equity have little or nothing to do with these claims, and that the only limit to the demands is the extent to which the employers can be squeezed. That limit has now been reached in the tramways industry, and it will not be long before it occurs in others.

The Slump.

WHAT effect the prophesied slump will have on the electrical industry is a question well worthy of the closest consideration. The break in prices which we are told may occur in certain markets at any moment will not be so much due to overproduction but to the consumer beginning to get a little tired of being asked to buy at the prices which rightly or wrongly he considers excessive. He is thus becoming more exacting in his requirements and less anxious to buy unless he is absolutely obliged. Manufacturers will find it difficult to counteract this form of striking by reducing the wages of their work-people or even by heroic discharges without incurring the displeasure of the Labour organisations and possibly bringing about a state of affairs which would defeat their own ends. But there are two other ways in which the situation may be met. One by persuading the workers that it is to their own benefit no less than that of their employers to produce more, and the other by revising their methods of manufacture with a view to increasing their efficiency. There is no doubt not only that a great deal can, but must, be done in the latter direction, and here is surely a great opportunity for the electric supply and manufacturing industries. The advantages to be gained by the use of the electric drive are still a closed book to many, while what may be done by employing electric heating in industrial work is a closed book to many more. When trade is bad the progressive man becomes receptive to new ideas, the development of which will aid in increasing his business and reducing his costs. There is every reason why we should do our best to take advantage of this state of affairs and so increase our own production at a time when conditions in other markets will be most favourable for that purpose. It should be a great opportunity for combined effort in the electrical industry and we hope full advantage will be taken of it.

The Demise of the Engineering Industry.

We had written thus far when our attention was called to what is nothing less than an obituary notice of the engineering industry as we understand it to-day. Its murderer, sexton and chief mourner is a Mr. Tom Emery, who, in addition, is the inventor of an automatic power generating motor which will produce power without fuel, stimulate output, provide cheaper transport and crush Bolshevism. These motors are, we understand, self starting and self-stopping, and although at present they do not seem to be self-creative that will doubtless be the next step. "Though the new motors embody a great number of discoveries, an engineer can readily understand them" we quote Mr. Emery—but unfortunately that is of little use, as the sole rights have been granted to a special company (of which we suppose the prospectus may shortly be expected), whose operations are for the present wrapped in the usual mystery. We trust we do not look with too jaundiced an eye on the enthusiasm of inventors, but we are a little afraid that Mr. Emery, besides protesting too much, is over optimistic. Until we are given a little more information as to his wonderful scheme we must class him with those who devise perpetual motion machines and produce Bachelet railways for the delectation of unsuspecting curates and Government officials and the sorrow of those who desire real engineering progress.

The Englishman Abroad.

In the past the Englishman abroad, especially if he had anything to do with trade, was generally a sore trial to the diplomatic and consular authorities. There was an official lack of understanding of the proper object of consular officials of which lack the appointment of foreigners as British consuls in some of the smaller towns is sufficient indication. Indeed, instead of assisting British trade such appointments were an entirely gratuitous hindrance to its development. The whole consular policy was in fact wrong. The Englishman trading in a foreign country is a veritable outpost of Empire, and as such is entitled to all the assistance which the Government and the commercial community in this country can give him. We are therefore glad to see that a Committee appointed by the Foreign Office to inquire into the conditions of the British citizens living in countries abroad have in a report just issued made certain recommendations, which, if adopted, will remove many of the impediments that have existed in the past.

Government Support Necessary.

The conditions brought about by the war naturally led British subjects to combine in defeating enemy influence. This combination in its turn engendered a spirit of co-operation which may, if properly employed, be turned to the very greatest use. To ensure this, however, the Government must show that they intend to provide these countries with practical support and, while refraining from interference, do all they can to assist in spreading British ideals. It has often been found that such relatively small matters as the establishment of an English school or an English church in a foreign town is of the very greatest use in forming a centre for the generation of increased goodwill in the relations not only between the Britishers themselves, but with the foreigners among whom they are living. Putting it at its very lowest value this goodwill is good for trade. The same may be said for British Chambers of Commerce which properly administered should become a valuable link in our commercial machinery. Care is necessary in their formation, however, for as the Committee quite rightly point out the admission of foreigners to the full membership of these bodies is giving an undesirable hostage to fortune. We also agree that these Chambers should not be subsidised from national funds, though the Government can give them great assistance, which is even more useful than money, by providing them with information, redressing grievances and generally smoothing their path in a hundred and one different ways.

Foreign Trade and Technical Literature.

The recommendation that at every British consulate there should be available a list of the best standard English books and journals is one with which we are in the closest agreement. English technical literature, though often of the highest class, is not by any means as well known abroad as it should be. This seems to be due to a lack of organisation, on the part of our publishers rather than our educational authorities. A central British Institute in the larger towns would also seem to be desirable if not essential, while equally badly required is some permanent machinery whereby the wants and difficulties of those living abroad may be brought to the attention of the home Government. All these things are closely connected with the development of our foreign commerce and should therefore be closely studied by electrical engineers. Such a policy is advertising of the best kind. And advertising is necessary if we are to maintain and increase our foreign trade.

A Substitute for Paper.

The cost of paper is a mournful fact with which all journalists are now familiar. It may be that the anticipated slump in the price of other commodities will extend to paper eventually, but of this there is no immediate prospect. There has been much speculation on possible new sources of raw material, such as esparto grass and the reeds and other vegetation available in large quantities in Egypt and elsewhere; but it is scarcely conceivable that we shall live to see a partial reversion to the use of papyrus, wax tablets and other devices of bygone ages. There is, however, one possible substitute for paper, for we recall that, long before the present crisis, Edison had suggested the use of thin sheets of aluminium or other suitable metal, to be coated with a suitable white base, and subsequently to receive an imprint in ink. One incidental advantage of such a method, which at the time was deemed wildly improbable, would be the thin nature of the sheets, and the consequent diminution in the bulk of volumes, rendering possible the general use of type of large size.

Germania Rediviva?

It is very difficult to find out exactly what the state of affairs is in industrial Germany. Visitors to that country return with such varying accounts that we must presume they see what they want to see and arrive at the conclusions they most desire to reach. In this they are no doubt assisted by the wily native, who has little to learn in the arts of subterranean propaganda. One of his latest efforts in that direction is the publication of a journal entitled the "Export and Import Review," written and printed in English but bearing nevertheless unmistakeable marks of the country of its parentage. Merely as propaganda it is worth reading and digesting. A recent issue contains an account of the "world's largest turbine and transformer." This is a 75,000-h.p. unit constructed by the A.E.G. during the war. Owing to the shortage of raw materials the parts usually made of nickel steel and bronze had to be constructed of low grade metal and made proportionately heavier. The weight of the armature was 106 tons and of the alternator 225 tons. The turbine rotor weighed 19 tons and the complete turbine 250 tons. The transformer used in connection with this machine stepped the pressure up from 7,000 to 110,000 volts. This transformer weighed 116 tons, of which the winding accounted for 15 tons. It is evident from this that the undoubted enterprise of the German engineer is still in being and that he will probably be as formidable a competitor in our foreign, if not in our home trade, as he has been in the past if he is only given the chance.

Engineering Education in America.

When an engineer of the high standing of Prof. C. F. Scott, of Yale University, speaks on the subject of engineering education we shall do well to listen; for not only may such a speaker throw some light on a subject which, though it has lately been closely dissected, has not been much illuminated, but, speaking as he does from the American view point, he may, by accentuating the differences between methods in that country and our own, show us where our difficulties lie. These difficulties are insistent and profound, and are mainly caused by the very progress we are making in engineering knowledge. For if British engineering is to continue to deserve that high name for enterprise and workmanship which it has so long possessed, the education of our young engineers must certainly include those vitalising ideas which fresh knowledge brings in its train. And it must not be forgotten that increased knowledge means increased responsibility for those who teach.

Good Foundations.

"Engineering," as Prof. Scott truly says, "is a method of thinking, of dealing with things constructively, a scientific method of getting data, analysing it, of drawing conclusions, and then of applying those conclusions and carrying them through to some useful end." The broadest training, therefore, must be the best, and to provide proper education in such a subject the closest attention must be paid to the laying of a good foundation, and to instilling in the student's mind such fundamental knowledge that, upon the good foundation so provided, he will be able to erect for himself the superstructure best suited to his own needs. The curriculum, in fact, should be so arranged not so much to teach as to inspire. This is particularly important in the first year.

Primary Education at the University.

Among teachers with progressive outlook there will be general agreement on this point. And we are glad to learn that advantage has been taken at Yale of the extension of the normal engineering course from three years to four years, not to increase the amount of engineering instruction given, but rather to pay more attention to English, economics and athletics. In short, by giving a broader training, to show students where the basic principles of engineering lie, and to arouse within them that intellectual power whereby they can acquire knowledge for themselves.

The real difficulty that faces the general adoption of this arrangement is that any engineering course of practicable length is all too short for the work that must be done in it. And it may well be argued that the proper place for instruction in such so-called elementary subjects as those mentioned by Prof. Scott is in the primary schools, and by time the student comes to a technical school he should have realised that athletics is rather a means to an end than an end in itself. Reform of technical education must, therefore, be accompanied, if it is not preceded, by a reform of much of our primary education, a good deal of which seems to have the effect of making the pupil more ignorant than he naturally would be. In the United States matters may, of course, be different; but, even there, we should have thought it would have been better to confine an engineering course to the study of fundamental scientific subjects, rather than to widen its basis in quite the way that has been done at Yale.

A Tasting Year.

But in one feature of their curriculum the Yale engineering school has set an example that might very well be followed in this country. The student is not permitted to decide until the end of his first year course in what branch of engineering he wishes to specialise. During the year the fields of the different branches of engineering are indicated to him by lectures. The student also visits the laboratories in all the different departments, receives general instruction in certain specialised subjects, such as illumination and telephony; and generally is encouraged to find his own particular bent. This is a most wise arrangement, especially as through it all the greatest insistence is placed on the necessity for a knowledge of mathematical and physical principles in the development of modern engineering science and technology. It is an arrangement which our own educational authorities might well consider, as we feel sure that its adoption in the widest form would bring with it many advantages.

The Teacher's Responsibilities.

That such a system as this imposes great responsibilities on the teacher is evident. It not only demands from him almost expert knowledge in several subjects at a time when expert knowledge in one is only achieved by the closest application to that subject, and to that subject alone; but it also demands the very highest of human qualities in order that knowledge may be imparted in the right way, and the pliant young minds rightly shaped when they are most responsive to either good or bad influence.

The Choice of the Teacher.

A man fulfilling these conditions is not to be found at every street corner. When found he should be treasured. But, unfortunately, the paramount importance of this policy seems to be as little realised in the United States as it is in this country. In spite of munificent endowments and high fees, the remuneration given to the teaching staffs is still very low, and it is not, therefore, surprising to learn that more and more of these engineering teachers, among whom the most enterprising are naturally included, are being drawn away to commercial life. This is not as it should be. Engineering and engineering knowledge are of the very structure of our modern life. If that structure is not to be weakened, everything must be done to add to our knowledge, both of fundamentals and of correlated phenomena. That can only be effected by constant study both by students and by teachers. Every facility should, therefore, be given to the latter to gain fresh knowledge, so that they may in their turn impart it. Much has been done in this direction by granting leave of absence and permitting private work; but it is not yet realised that the first thing to do is to pay proper salaries. This is so logical that it seems strange it should for so long have been neglected. For good pay good men will be obtained; and the reverse is equally true.

Electric Winding Engines and Mine Hoists.*

By H. H. BROUGHTON.

(Continued from page 516.)

COMPOUND SHAFTS.

Although winders for compound shafts are regarded as old fashioned, cases arise in which it is more economical to use this type of winder than to adopt stage winding.

As an example of the latter may be given the three-stage hoisting in use at Crown Mines, Ltd., Transvaal†. The vertical portion, 1,085 ft. deep, was deepened 120 ft. in order to make room for storage bins between the inclined shaft and the loading box of the vertical shaft. Each stage of the hoist has four hoisting compartments. The second stage, 2,004 ft. long, is in the upper part of the incline, its hoist being located in a chamber near the intersections of the vertical and inclined portions, as shown in Fig. 16. Below level 13, at the foot of the second stage, is the third stage, with its hoist in the level above, and the method of transferring the ore from the third to the second stage is illustrated in Fig. 17. It is interesting to note that these two shafts replace 11 old shafts formerly in use.

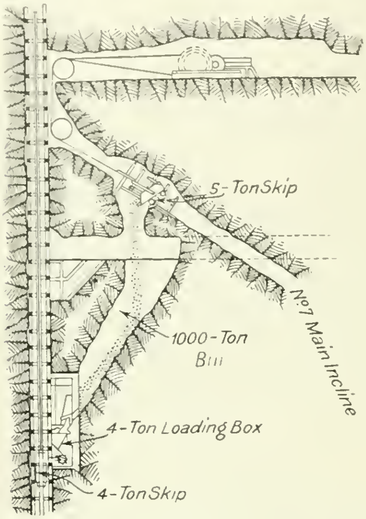

Fig. 16.—Transfer Point at Bottom of Vertical Shaft.

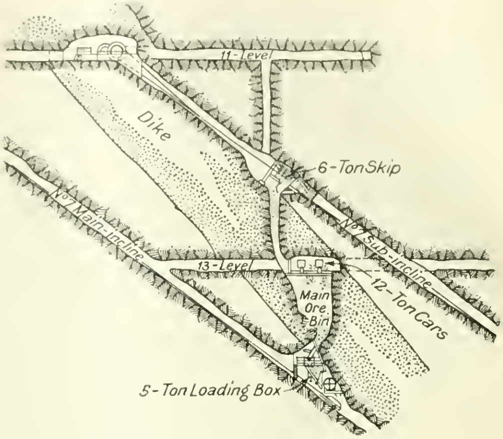

Fig 17.—Transfer from Third Stage to Second Stage.

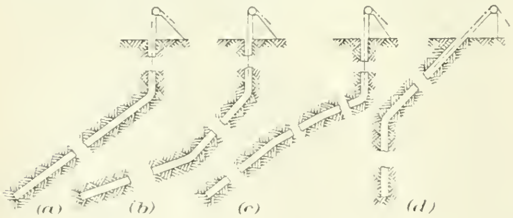

Fig. 18.—Typical Compound Shafts.

Reference will be made later to stage winding, and in this article it is proposed to give a number of examples in which a single winder at the surface serves for both the inclined and vertical portions of the shaft, Fig. 18 (*a*) to (*d*). Of these examples, three will be worked out for the shafts (*a*), (*c*) and (*d*), Fig. 18, so as to make clear the mechanics of this type of hoist. In addition, simple and equalised Ward Leonard problems will be given.

Hitherto for all the examples British units have been used. As many engineers prefer to work to the metric system, we shall now proceed to give an example in which the metric system is used.

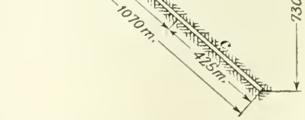

Fig. 19.—Compound Shaft.

Example.—The leading data of a geared three-phase winder for a compound shaft are given below. It is required to find the rating of the driving motor.

Rock	2,730 kg.
Skip	2,730 kg.
Shaft (Fig. 80)	425 m. vertical. 1,070 m. inclined at 43 deg.
Rope	3·43 kg. per metre.
Output per hour	50 tons (m).
Maximum speed	10·15 m. per sec.
Speed at bend reduced to	5·08 m. per sec.
Drums.—Twin cylindrical, 2·44 m. dia.;	$WR^2/g = 18{,}000$.
Sheaves	$WR^2/g = 6{,}000$ (total).
Loading time	20 sec.
Motor.—Three-phase, 50 cycles, 360 revs. per min.	

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† Mining Engineers' Handbook, Peele, p. 910.

Approximate Motor Output.—Had the wind to be made at a mean speed of 10·15 m. per sec. it would take (1,070 − 425) ÷ 10·15 = 147·3 sec. to complete the wind, and in this time the nett load of 2,730 kg. would have been raised a distance of 730 + 425 = 1,155 m. Hence the work done per sec. = $\frac{2{,}730 \times 1{,}155}{147·3}$ = 21,400 kg.m. Remembering that the horse-power is defined as the rate of doing 75 m.kg. of work per sec.; also that the motor output will be about twice that expended on the load, we get

$$\text{Probable H.P. of motor} = \frac{21{,}400}{75} \times 2$$
$$= 570.$$

A 50-cycle machine of this size, running at 360 revs. per min., will have a rotor GD^2 of 3,100 kg.m.^{2}; and, since a linear speed of 10·15 × 60 = 609 m. per min. corresponds to a drum speed of 609 ÷ 2·44π = 79·3 revs. per min., it follows that the gear ratio = 360 ÷ 79·3 = 4·54 to 1.

Sub-division of Cycle.—To obtain an output of 50 tons (m) an hour at 2·73 tons per wind there will have to be 50 ÷ 2·73 = 18·3 winds per hour; hence duration of wind = 3,600 ÷ 18·3 = 197 sec. Deducting from this the 20-sec. interval we get 197 − 20 = 177 sec. as the nett winding time to obtain the required output. To be on the safe side it is advisable to reduce this nett winding time by a few seconds.

At the bend, the speed of the skips is reduced from 10·15 m. per sec. to 5·08 m. per sec. The following times are taken for accelerating and retarding:—

Initial acceleration	14 sec.
First retardation	9 sec.
First re-acceleration	10 sec.
Second retardation	9 sec.
Second re-acceleration	10 sec.
Final retardation	16 sec.
Total	68 sec.

The lines of Table VIII. numbered 1, 3, 4, 6, 7 and 9 can now be filled in, remembering that during initial acceleration and final retardation the average speed is half the maximum speed, namely, 10·15 ÷ 2 m. per sec.; and that during the two slow-down periods the average speed is (10·15 + 5·08) ÷ 2 m. per sec.

Table VIII.—*Sub-division of Winding Cycle and Distances Travelled.*
Total length of shaft = 1,495 m.; Max. speed = 10·15 m. per sec.; Speed at bend = 5·08 m. per sec.

Reference.	Period.	Duration sec.	Distance moved through, metres.		Time in sec. since beginning of wind.
			During period.	Since beginning of wind.	
				0	0
1.	Initial acceleration	14	71	71	14
2.	First constant speed	28·2	285·4	356·4	42·2
3.	First retardation	9	68·6	425	51·2
4.	First re-acceleration	10	76·1	501·1	61·2
5.	Second constant speed	49·3	500·3	1,001·4	110·5
6.	Second retardation	9	68·6	1,070	119·5
7.	Second re-acceleration	10	76·1	1,146·1	129·5
8.	Third constant speed	26·4	267·6	1,413·7	155·9
9.	Final retardation	16	81·3	1,495	171·9

In Fig. 20 (*a*) the speed is shown plotted to a time base.

Static Forces.—These will be considered in the following order: Ropes, total friction, ascending skip and load, and descending skip.

Ropes: The graphical method already described in the article on Inclined Shafts* will be used.

Referring to Fig. 20 (*a*) the equivalent full-speed value of the first portion of the wind, *i.e.*, till the descending skip reaches the bend, is 425 ÷ 10·15 = 41·95 sec.; and, since the distance covered in the two cases is the same, the equivalent value of the third portion of the wind must also be 41·95 sec. For the second portion of the wind the equivalent full-speed time is (1,070 − 425) ÷ 10·15 = 63·55 sec. These several times are shown in Fig. 20 (*a*) and are bounded by the vertical cross-hatched lines.

At the beginning of the wind the rope pull on the ascending side due to the rope is:—

$$\begin{array}{ccccc} \text{Vertical} & + & \text{Inclined} & = & \text{Total pull} \\ (425 \times 3·43) & + & (1{,}070 \times 3·43 \times 0·682) & = & 3{,}960 \text{ kg.} \end{array}$$

This is represented by *OA* in Fig. 20 (*b*). The line *OA* is subdivided into the three parts *a*, *b* and *c* shown; where *a* = 1,460 kg. is the pull due to the 425 m. vertical length of rope, *c* = 1,000 kg. is the pull due to a 425 m. inclined length of rope, and *b* = 1,500 kg. is the pull due to the remainder, namely, 645 m., of the inclined rope. These load lines are projected horizontally, and the equivalent full-speed times are projected vertically downwards from Fig. 20 (*a*).

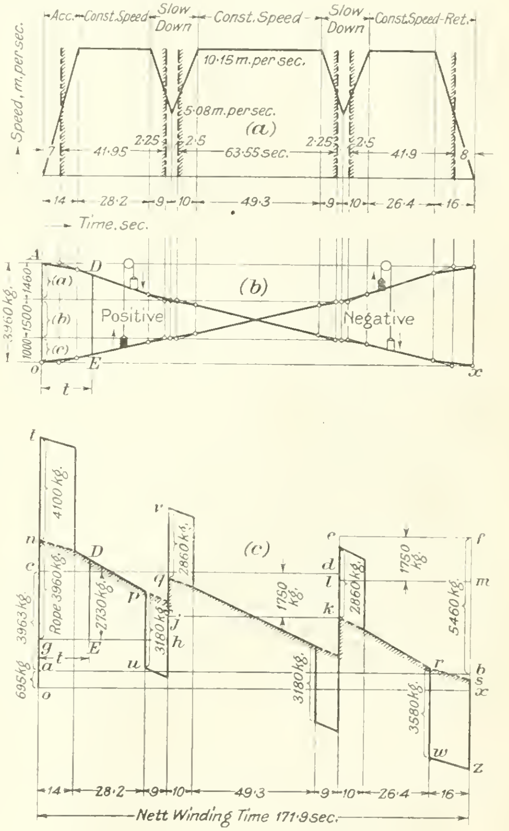

Fig. 20.—Diagram for Balanced Winding.

Lines drawn through the points of intersection of these projectors, when corrected in the manner already described for the starting, slow-down and stopping periods, give the rope pulls due to the ascending and descending ropes.* The vertical intercept is the resultant pull due to both ropes; thus, after *t* sec. the resultant rope pull is represented to a known scale by the intercept *DE*.

Friction: For general shaft friction we shall allow 6 per cent. of the weight of the loaded and empty skips. Hence,

$$\text{Shaft friction} = 0·06 \{(2{,}730 + 2{,}730) + 2{,}730\}$$
$$= 495 \text{ kg.}$$

Although the length of rope in the inclined portion of the shaft varies from instant to instant, we shall assume a constant length of 1,070 m. for the rope friction allowance.

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* The Electrician, p. 441, April 23, 1920.

* The reader is advised to view each rope-line end on with his eye placed level with the paper.

$$\text{Rope friction} = 0{\cdot}05 \times \cos 13 \times 1{,}070 \times 3{\cdot}43 = 200 \text{ kg.}$$

Referring to Fig. 20 (c) a length Oa representing $495 + 200 = 695$ kg. to the given scale is marked off vertically above O, and the line ab, to the base Ox, shows the friction at every instant throughout the wind.

Ascending skip: Assuming an angle of friction of 3 deg., then the rolling friction coefficient $= \cos 13 \times \tan 3 = 0{\cdot}013$ and, as long as the skip is on the incline,

$$\text{Rope pull} = (2.730 + 2.730) \times (0{\cdot}682 + 0{\cdot}013) = 3.963 \text{ kg.}$$

This load is represented by ac in Fig. 20 (c) and through the point c is drawn the line cd, the location of point d being such that the ascending skip is about to enter the vertical portion of the shaft.

With the ascending skip in the vertical shaft, the rope pull is simply $2.730 + 2.730 = 5.460$ kg., and this load is represented by the line ef, where the length bf is marked off equal to 5,460 kg.

The stepped line $cdef$ to the base ab shows the rope pull at every instant due to the ascending skip.

Descending skip: As long as the descending skip is in the vertical shaft the rope pull is simply the weight of the empty skip, namely, 2,730 kg. Let this load be marked off below c and represented by the length cg. Through g draw a horizontal line gh, the point h being the instant when the descending skip is about to enter the incline.

With the skip on the incline,

$$\text{Rope pull} = 2.730(0{\cdot}682 - 0{\cdot}013) = 1{,}750 \text{ kg.}$$

This when marked off below the stepped base $gdef$ is represented by the stepped line $jklm$.

Total Static Forces plus Friction: The stepped line $ghjklm$ to the base Ox represents the rope pull due to the ascending and descending skips plus shaft and rope friction.

By marking off on this stepped base the resultant pull due to the ascending and descending ropes we get the curve of static forces at every instant throughout the wind. From Fig. 20 (b) it will be noticed that t sec. after the commencement of the wind the resultant rope pull is DE; move this vertically downwards to DE in Fig. 20 (c), then D is a point on the curve. Other points are found in a similar manner and, bearing in mind the reversal of the sign of the rope pull, the curve of static forces is represented in Fig. 20 (c) by the stepped sloping line $n \ldots\ldots s$.

Dynamic Forces.—The equivalent masses at the periphery of the drum are:—

Motor: $GD^2 = 3.100 \text{ kg.m}^2$

$$\text{Equivalent mass } M_1 = \frac{3{,}100 \times (1{\cdot}5)^2}{(2{\cdot}44)^2 \times 9{\cdot}81} = 1{,}075$$

Rotating parts: Two drums $WR^2/g = 18{,}000$
Two sheaves „ $= 6{,}000$
Gearing „ $= 4{,}500$

$$M_2 = \frac{28{,}500 \times 5{\cdot}43^*}{(2{\cdot}44)^2 \times 9{\cdot}81} = 2.650$$

Linear moving parts: Nett load $= 2{,}730$ kg.
Two skips $= 5.460$ kg.
Rope $= 2(1{,}070 + 125 + 50) \times 3{\cdot}43 = 10.600$ kg.

$$M_3 = \frac{18{,}790}{9{\cdot}81} = 1{,}915$$

and, equivalent mass $M = 5{,}640$

The momentum of this equivalent mass at 10·15 m. per sec. is $5.640 \times 10{\cdot}15 = 57.250$ kg. sec. and at half speed, namely, 5·08 m. per sec. the momentum is 28,625 kg. sec. The forces necessary for accelerating and retarding, found by dividing the change of momentum by the time in which the change takes place, are therefore:

Initial acceleration $= 57{,}250 \div 14 = 4{,}100$ kg.
First and second retardation $= (57{,}250 - 28{,}625) \div 9 = -3{,}180$ kg.
First and second re-acceleration $= (57{,}250 - 28{,}625) \div 10 = 2{,}860$ kg.
Final retardation $= 57.250 \div 16 = -3.580$ kg.

These forces when combined with the static forces, in the manner shown in Fig. 20 (c), give the total pull, at the drum periphery, at every instant. This total pull is represented by the curve $Ot \ldots zxO$, and from it can be found the resultant torque and the horse power for determining the rating of the motor.

Torque Diagram. By scaling the ordinates of the cardinal points of the diagram $Ot \ldots zxO$, and multiplying these by the drum radius we obtain the torque *at the drum shaft.* The diagram $Ot \ldots zxO$, Fig. 20 (c), is, therefore, the torque diagram to a known scale.

Power Diagram.—But for the reversal of torque at certain points of the wind the diagram $Ot \ldots zxO$, Fig. 20 (c), would also be the *rating power diagram* to a known scale.

Assuming a gear efficiency of 95 per cent., when the torque is positive, that is, when the motor is driving, motor output

$$\text{H.P.} = \frac{\text{Torque} \times 2\pi \times 79{\cdot}3}{4{,}500 \times 0{\cdot}95} = 0{\cdot}116 \times \text{Torque (kg.m)},$$

and, when the torque is negative, that is, when the motor is being driven, motor output

$$\text{H.P.} = \frac{\text{Torque} \times 2\pi \times 79{\cdot}3}{4{,}500} \times 0{\cdot}95 = 0{\cdot}105 \times \text{Torque (kg.m)}.$$

For convenience the diagram $Ot \ldots\ldots zxO$ has been transferred from Fig. 20 (c) to Fig. 21, and for each of the cardinal points the corresponding pull at drum radius, torque at drum shaft and motor output are given. Thus, at the end of the initial acceleration the pull is 9,500 kg., the torque is $9{,}500 \times 1{\cdot}22 = 11{,}600$ kg.m., and the motor horse-power output is $11{,}600 \times 0{\cdot}116 = 1{,}350$. Similarly, at the end of the wind, pull $= -3.200$ kg., torque $= -3{,}900$ kg.m., and motor output $= -3{,}900 \times 0{\cdot}105 = -410$ H.P.

Motor Rating. On the diagram, Fig. 21, will be noticed a number of chain dotted lines. *These represent true outputs of the driving motor and have nothing whatever to do with the rating of the motor.* The latter, as we have already seen, is determined from the fictitious output, which is represented by the full-line curve. The corresponding heating curve, found by squaring the ordinates of the output curve, is shown cross-hatched.

From the notes already given in these columns the reader will remember that the virtual rating is found by dividing the cross-hatched area by the equivalent full-speed value of the cycle and taking the square-root of the quotient. As regards the equivalent value of the cycle, the times are:—

Period.	Actual time, sec.	Equivalent full-speed, sec.
Acceleration	14	$14 \times 0{\cdot}5 = 7$
First full-speed	28·2	28·2
First slow-down	19	$19 \times 0{\cdot}75 = 14{\cdot}2$
Second full-speed	49·3	49·3
Second slow-down	19	$19 \times 0{\cdot}75 = 14{\cdot}2$
Third full-speed	26·4	26·4
Final retardation	16	$16 \times 0{\cdot}5 = 8$
Interval	20	$20 \times 0{\cdot}25 = 5$
Total		152·3 sec.

Since the H.P.^{2}-time diagram has an area of about $75{\cdot}2 \times 10^6$ H.P.^{2} sec. it follows that the virtual rating of the motor is

$$\text{H.P.} = 1{,}000 \times \sqrt{75{\cdot}2 \div 152{\cdot}3} = 700$$

Turning back to the beginning of the example it will be seen that the approximate output of the motor was found to be

---

* $GD^2 = 5{\cdot}43\, WR^2 \div g$.

570 h.p. The assumed inertia of the rotor is, therefore, on the low side, but the error is small because the rotor inertia is only about 20 per cent. of the total and no correction need be applied.

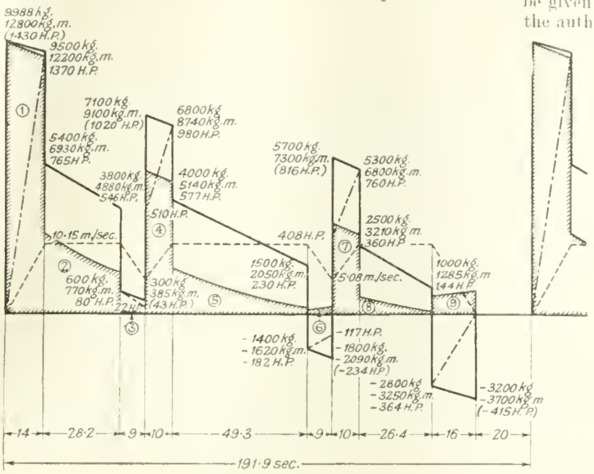

Fig. 21.—Output Diagram for Rating.

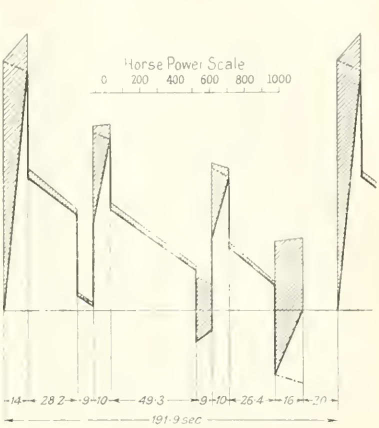

Fig. 23.—Input and Output Curves.

In the case of a large underground hoist the dissipation of this large amount of heat may be difficult, particularly when a supply of cooling water is not available. A description will be given later of an air-cooling system that has been used by the author.

The performance curves of the motor that was put forward for this winder are given in Fig. 22, and from the efficiency curve the output-loss curve has been plotted. Knowing the output at every instant, Fig. 21, the loss at every instant throughout the wind is known, and hence, by adding the known output and loss, the theoretical motor input is known. The input diagram is depicted in Fig. 23, and the cross-hatched area represents loss.

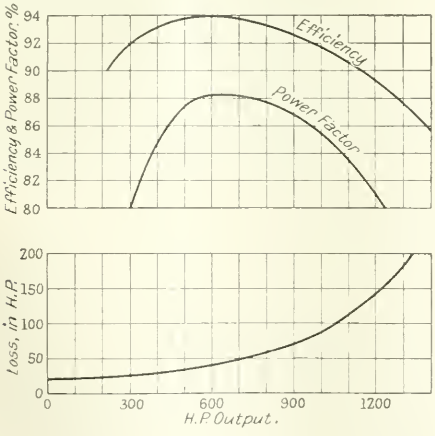

Fig. 22.—Efficiency, Power Factor and Loss Curves.

In the last paragraph, reference was made to the theoretical motor input. In practice the actual input is usually much greater than that calculated by the electrical manufacturer, because the inefficiency of the liquid controller is usually neglected. This is seldom taken into consideration by advocates of the three-phase system of winding, and is probably never referred to by the controller maker. That the loss is considerable may be shown by taking the full-load running speed of the motor with the controller electrodes in their lowest position, or with the operating lever hard over. Thus, suppose that a motor having a theoretical speed of 375 revs. per min. is found to run at 340 revs. per min. The difference is 35 revs. per min., or 9·34 per cent. of the theoretical speed, and the loss due to the resistance of the rotor, connecting leads and liquid controller is 9·34 per cent. of the input from the line.

The torque conditions are entirely different when the shaft starts in the vertical and runs out on the incline, as shown in Fig. 24. Data on such a hoist, of which the author has knowledge, are given below :—

Rock	8,000 lb.
Skip	4,000 lb.
Shaft	425 ft. inclined at 45 deg. 450 ft. vertical.
Rope	2·1 lb. per ft.
Output per hour	240 tons.
Maximum speed	2,000 ft. per min.
Speed at bend reduced to	1,000 ft. per min.

Drums.—Twin cylindrical; 8 ft. dia. · 4 ft. wide; $WR^2/g = 16{,}000$.

Loading time	10 sec.

Motor.—Direct current, 500-volt, 485 revs. per min.

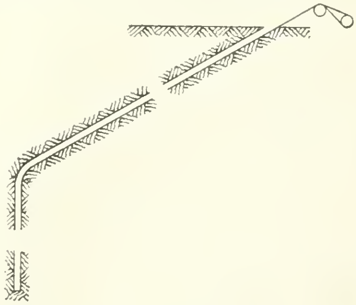

Fig. 24.—Compound Shaft.

The time allowed for acceleration was 16 sec., and for retardation 11 sec.

At the beginning of the wind it will be noted that, on the ascending side, in addition to a 875 ft. length of rope there is a loaded skip weighing 12,000 lb. On the descending side there is merely the pull due to an empty skip, of 4,000 lb. weight on an incline of 45 deg. This pull only amounts to about 2,800 lb., and the torque conditions, therefore, are very severe. Following the method already described, the reader should have little difficulty in drawing the torque diagrams and in finding the rating of the motor. A motor of 750 h.p. was put forward for this winder. It may be mentioned, in passing, that since the inclined and vertical portions of the shaft are practically equal in length, only one slow-down is necessary because the two skips pass the bend simultaneously.

(*To be continued.*)

Permanent Magnets in Theory and Practice.*

By S. EVERSHED.

(*Continued from page* 592.)

Part II.

DESIGN AND PREDETERMINATION OF PERMANENT MAGNETS.

Magnetic Energy of a Magnet.

The fundamental equations of the permanent magnet can be deduced directly from the principle of equivalence. The negative portion of the cyclic curve gives the relation between the extraneous motive force applied in the negative direction and the flux density in a self-absorbed circuit; and the negative force so applied is numerically equal to the surplus motive force available for use outside a magnet made from the same kind of steel as the sample.

The development and application of the working equations will be readily understood. The total quantity of energy which the magnet will be required to maintain is not difficult to estimate. The author illustrates this by considering a simple magnet with pole-pieces and air-gap. The calculation is simple in principle, although, when leakage is taken into account, the best dimensions for the magnet are only reached after several approximations.

The Demagnetisation Curve as the Basis for Design and Predetermination.

The first step towards a forecast of the performance of a magnet is to obtain the demagnetisation curve of the steel from which the magnet is to be made. Naturally, such data forecast what the magnet would do when fully magnetised. Magnets are, however, seldom so used, and an allowance must be made for the intended difference between the maximum and the working strength of the magnet. The desirable percentage reduction in strength depends on the anticipated circumstances of use. Therefore the gross energy requirement is taken as the basis for both design and predetermination; thus, when the finished magnet has been intentionally reduced in strength by the given percentage, it will fulfil the actual net requirement.

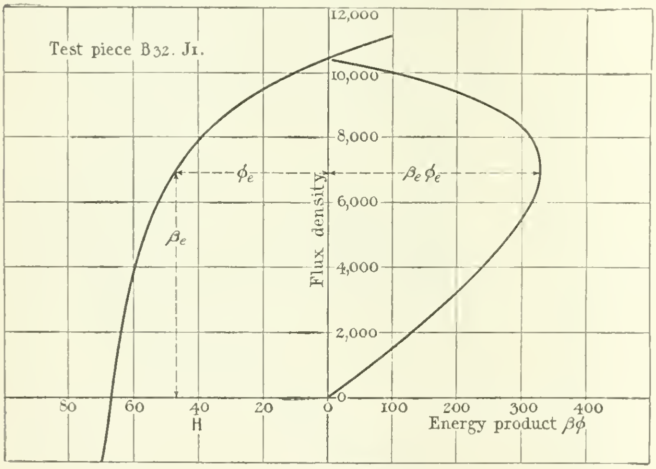

Fig. 1.—Typical Demagnetisation Curve for Magnet Steel, showing the Derived Curve of the Energy Product βφ.

Values on energy scale multiplied by 1,000 8π give energy in ergs.

A typical demagnetisation curve is shown in Fig. 1 for hardened tungsten-carbon magnet steel. The curve represents the relation between an extraneous motive force, **H**, and the flux density **B** in a "self-absorbed" magnetic circuit. However, the magnetic circuit of a useful magnet must necessarily be an "extended" circuit. Hence the negative force **H** corresponding with **B** at any point on the curve in Fig. 1 will be numerically equal to the surplus motive force φ created by the steel at any point inside the magnet where the induction β is equal to **B**.

Fundamental Equations for an Ideal Magnet.

It is customary to supply magnet steel in rolled bars. Hence the sectional area of a magnet is constant along its length. Leakage from one limb of the magnet to the other therefore involves a variation in flux density from a maximum at the "neutral section" to a minimum at the ends of the magnet. In an ideal magnet the rate of decrease in area of the limbs is equal to the rate at which the flux decreases by leakage, so that the flux density in the steel is uniform. Such magnets utilise the steel to the best advantage, but until one can make permanent magnets in the form of magnet steel castings, so that the sectional area can be varied appropriately, the magnet of uniform density must be regarded as an ideal type.

The author next considers two magnets of uniform density, the first being a bent magnet, used in conjunction with two pole-pieces for maintaining a magnetic field in an air-gap. The flux density being uniform, the lines of induction in the steel will lie parallel with the magnetic axis of the magnet. We may regard an ideal magnet as consisting of two parts having distinct functions; a central core of uniform cross-section, which carries the flux delivered to the pole-pieces; and an enveloping tubular portion of gradually decreasing sectional area, carrying the leakage flux passing from one limb to the other, the latter forming a "leakage sleeve." Denoting the length and sectional area of the core by L and A respectively, we have $B=\beta A$ and $V=\varphi L$. Any number of magnet cores might be made on the basis of the primitive equations containing widely different volumes of steel, but each delivering the required terminal flux at the required terminal P.D.

The necessary condition for economy of steel will be apparent if we multiply the two primitive equations together, thus obtaining the fundamental energy equation $BV=\beta\varphi LA$.

The product βφ ("betaphi") is the available or useful energy per cubic centimetre of magnetised steel. If our object is to use the smallest volume of steel which will suffice to provide for the given energy requirement, the flux density must be such as to give betaphi the maximum possible value. This is obvious from the shape of the demagnetisation curve, and it is easily found by reckoning the product βφ, or **BH**, for a number of corresponding co-ordinates of the demagnetisation curve, and plotting them as points on a derived curve connecting betaphi with either β or φ, as in Fig. 1.

Denoting the economic density by β_e and the corresponding surplus force by φ_e, the economic dimensions of the magnet core can be determined by inserting these particular values in the primitive equations.

Thus $$A_e=\frac{B}{\beta_e} \text{ and } L_e=\frac{V}{\varphi_e},$$

$A_e L_e$ being the smallest volume of steel, of the quality represented by the demagnetisation curve, which will maintain the external energy BV.

Magnets of uniform density being at present an impracticable form, the process by which the dimensions of the leakage sleeve are arrived at need not be discussed in detail. The outline of the sleeve, or growth in its sectional area, may be determined with sufficient accuracy by making step-by-step additions to the area. The flux density and surplus motive force will be β_e and φ_e in the sleeve as in the magnet core, and the magnetic energy in the leakage field extending from one limb to the other will be $\beta_e\varphi_e\times$ volume of sleeve. The total magnetic energy maintained by the magnet, in space external to itself, will be $\beta_e\varphi_e\times$ total volume of magnet. Although this relation only applies in this simple form to ideal magnets of uniform flux density, the same principle holds for ordinary magnets of uniform sectional area and varying flux density.

The converse problem of predetermining the useful energy which a magnet of given dimensions is next considered by aid of the primitive equations. Denoting the sum of the conductances of the air-gap and the leakage paths from one pole-piece to the other by k_a+k_p and putting $B/V=k_a+k_p$ the ratio equation becomes

$$\frac{\beta}{\varphi}=\frac{L}{A}(k_a+k_p),$$

by the aid of which, and from the curves already referred to, terminal flux and P.D. are readily forecast. The ratio equation is also only strictly true for magnets of uniform flux density, but may be applied in a modified form to the case of ordinary magnets. The task of finding the particular point on the demagnetisation curve where the co-ordinates have the required ratio is made easy by drawing a derived curve connecting the ratio β/φ with the flux density β.

Ellipsoid Magnet.

The second example of a magnet of uniform flux density is one of an academic type, the ellipsoid magnet being of little or no importance outside the laboratory. The author, however, discusses it in the original Paper in some detail in order to make clear several deductions which may be applied in practice to ordinary magnets.

Leakage Conductance.

Predetermination depends on close estimates of the conductance of leakage paths from one limb of a magnet to the other, and hence the conductance factor (the conductance per centimetre of zone width at any pair of corresponding zones on the magnet limb) is of great practical importance. In practice, q may be regarded as constant over the first half length of the limbs. It may also be safely assumed that for a region extending over half the length of the magnet the conductance factor will not be very different from the value of q for an ellipsoid, in which the proportion between length and diameter is the same. It is, therefore, convenient in practice to have at hand the means of determining q for any ellipsoid in terms of the dimension ratio c/a. This the author investigates mathematically, arriving virtually at the relation

$$q=\frac{\pi a^2}{c^2}\left(\frac{4\pi}{N}-1\right).$$

Since N depends only on the dimension ratio c/a the value of q also depends solely on the dimension ratio. A table of values for q in terms of c/a is given in the appendix of the original Paper,

From the ratio equation and the equation above the induction, total flux and surplus force in an ellipsoid magnet of given dimensions may be predetermined with accuracy by means of

$$\frac{\beta}{\varphi}=\frac{R}{r}=\frac{4\pi}{N}-1,$$

the separate values of β and φ being ascertained from curves derived from the demagnetisation curve of the steel. It may easily be shown that the magnetic moment of an ellipsoid magnet is

$$M=\tfrac{1}{3}a^2c(\beta+\varphi).$$

Also that, external energy of ellipsoid magnet $=\frac{2}{3}BV_t$.

Permanent Magnet Diagrams.

It is often useful to draw graphs showing the variation of the significant magnetic quantities along the length of a magnet. Such a diagram of this kind is given in Fig. 2 for the simple case of an ellipsoid magnet. Flux density and surplus force being constant, the graphs are straight lines parallel with the base line. The graph representing flux variation along the magnet is a parabola. The graph representing the accumulation of surplus force along the magnet is a straight line inclined at an angle to the base line. In similar diagrams relating to ordinary magnets in which the flux density is not uniform, the graphs for flux density, surplus force and P.D. show more or less curvature.

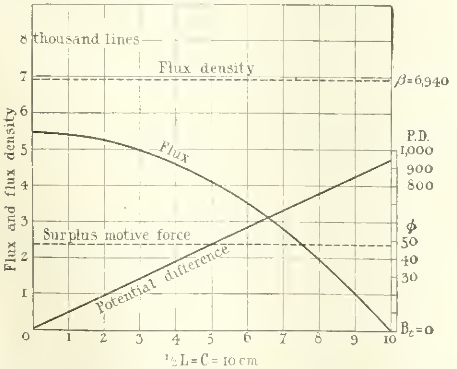

Fig. 2.—Magnet Diagram for an Ellipsoid Magnet of the same Steel as Test-piece B 32, J 1, length of Magnet 20 cm., Diameter at Neutral Section 1 cm., $c/a=20$.

Design of Economic Magnets.

Present-day practice gives the magnet uniform sectional area because magnet steel is supplied in rolled bars, and we are thus faced by the difficult problems which arise from variation of flux density in the steel. Although $\beta\varphi$ should attain its greatest possible value somewhere in each limb, the *average* value of $\beta\varphi$ for any range of variation in flux density must fall short of the maximum product. Some sacrifice in economy of steel is, therefore, unavoidable, and economy of steel cannot be based simply on the ideal economic density. We must aim at an economic *region*, giving to the highest practicable value for the average product $\beta\varphi$. In practice, if the *average* surplus force in the steel is nearly φ_e, the range of variation in flux density coincides sufficiently well with the most favourable region for economy of steel.

Design begins with an estimate of the approximate length L, and sectional area A of an economic magnet to fulfil some given energy requirement BV. The next step is to forecast what a magnet of that size will do, and then to make any final corrections in size that may be necessary. Again denoting the maximum betaphi product by $\beta_e\varphi_e$ the length of the magnet $L=V/\varphi_e$. It is seldom that any material correction of length so ascertained is required. The sectional area can usually only be determined by a series of approximations. We shall probably err on the safe side if we put the leakage flux $b=\frac{1}{2}Vk_c$, where k_c stands for the conductance of the leakage paths deduced from the final dimensions of the magnet. The total flux will be $B+b$. For an average density β_e we must find an area A and the corresponding leakage flux b which satisfies the equation $A=(B+b)/\beta_e$. This is done by a series of trials and approximations.

Predetermination of Ordinary Magnets.

Assuming the economic length and sectional area have been ascertained, the energy output of the magnet may be predetermined from the ratio equation, or more accurately by the laborious method of step-by-step integration. Take first the approximate method of the ratio equation. Assuming the leakage conductance of the magnet to be equivalent to a fictitious conductance αk_c connected at the ends of the magnet, the ratio equation is

$$\frac{\beta}{\varphi}=\frac{L}{A}(k_u+k_p+\alpha k_c).$$

Having thus depermined β/φ, the average surplus force is ascertained by reference either to the demagnetisation curve, or to a derived curve which gives φ in terms of β/φ. Denoting the value of the average surplus force by φ_a, the corresponding terminal P.D. will be $V=\varphi_a L$, and the useful flux $B_u=Vk_u=\varphi_a Lk_u$.

The terminal flux delivered to the apparatus will be $V(k_u+k_p)$, and the predetermined energy delivered by the magnet $V^2(k_u+k_p)$. It may next be necessary to modify the length and sectional area in order to obtain predetermined values for terminal P.D. and flux in close agreement with the two factors of the required energy.

The accuracy of a forecast depends on the value assigned to the coefficient α. In ordinary magnets α may have any value between $\frac{1}{3}$ and about $\frac{1}{2}$, but in a well-designed magnet leakage from limb to limb is not sufficient to require great precision in the estimated conductance αk of the equivalent leakage path. By assuming that an ordinary magnet, in common with an ellipsoid, behaves in some respects like a single magnetic circuit—we convert the ratio equation into a useful tool for the designer. The utility of the equation, however, is confined to the estimation of terminal P.D. and terminal flux. It does not reveal the distribution of flux and variation of flux density in the steel—on which economy and magnetic efficiency largely depend.

Predetermination by Step-by-Step Integration.

For a detailed estimate of the magnetic flux and energy maintained by a permanent magnet, we may suppose the magnet to be sub-divided into a number of lengths or regions within which β and φ may be treated as constant, their values changing *per saltum* in passing from one region to the next. This process is shown in Fig. 3. The magnet, of the uniform sectional area and of the best or horseshoe form, is shown as a development. The space to be magnetised consists of an air gap between two pole-pieces P_1P_2. Accuracy of predetermination does not greatly depend on the extent to which sub-division is carried. Two or three pairs of regions on either side of the central region are in nearly all cases sufficient, but to obtain data for graphs showing variation in flux density and other quantities along the magnet limbs, half-a-dozen pairs of regions would not be excessive.

The magnet in Fig. 3 is divided into five pairs of regions on either side of the central region.

The arithmetical process of summation or integration is set out in the original Paper in tabular form, and begins with the arbitrary choice of an initial flux density β_1 for the central region. Reference to the demagnetisation curve gives the corresponding value of φ_1 which, when multiplied by the length of the region, gives V_1 between the centres of the first pair of leakage zones. Denoting the sectional area of the magnet by A and the conductance of the first leakage path being $q_1 s_1$, the decrement in flux density at the junctions between the central region and the adjacent regions on either side of it will be $V_1 q_1 s_1/A$. In Fig. 3 this decrement is denoted by $\delta_1\beta$.

Next, by subtracting $\delta_1\beta$ from β_1 the density β_2 at the bottom of the first step in each limb is ascertained. The corresponding surplus force φ_2 is again ascertained by referring again to the demagnetisation curve of the steel. Thus $\varphi_2(s_1+s_2)$ is determined. Adding together V_1 and $\varphi_2(s_1+s_2)$ gives the P.D. V_2 between the centres of the second pair of leakage zones, and the decrement of density at the second step in each limb will be $V_2 q_2 \delta_2/A$. Denoting the second decrement in density by $\delta_2\beta$, the flux density at the bottom of the second step will be $\beta_2 - \delta_2\beta = \beta_3$ and again the corresponding value of the surplus force, namely, φ_3, is found by reference to the demagnetisation curve.

Proceeding in this way to the ends of the magnet, a terminal density β_6 is found, which when multiplied by A gives a terminal flux which we shall denote by B'. The successive additions of the increments of P.D. result in a terminal P.D. which is denoted by V'.

Let $k_a - k_p = k_t$, the total estimated conductance between the magnetic terminals of the apparatus. Now the flux and P.D. must necessarily bear a ratio to each other equal to the apparatus conductance k_t. But since our integration started with an arbitrary choice for the initial flux density, B'/V' could only turn out to be equal to k_t by some unexampled stroke of luck. We must, therefore, determine the initial density which, after integration, will result in a terminal flux B_t and terminal P.D. V_t, the values of which will make B_t/V_t equal to k_t. It is thus necessary to carry out a second and usually a third integration, similar to that just described, but beginning with different initial densities. It is good practice in the first integration to take some convenient number about 1,000 lines below the maximum remanent density. In exceptional cases a suitable figure for initial density can be found by means of the ratio equation.

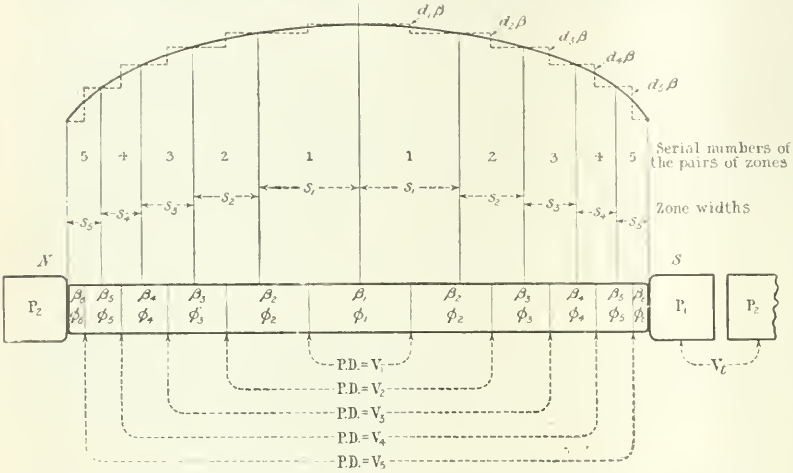

Fig. 3.—Diagram Illustrating the Method of Step-by-step Integration, the Length of the Magnet being Divided into Regions of Uniform Flux Density, and into Pairs of Leakage Zones.

We next draw a curve connecting initial density with terminal ratio. β'_1, with B'/V', β''_1 with B''/V'' and β'''_1 with B'''/V''' are plotted as co-ordinates and a curved line drawn freehand through the plotted points. The required initial density is then found by noting the point at which the line passes through the ordinate k_t. Similarly the terminal P.D. is found and also the terminal flux, in this case plotting B', B'' and B''' with the corresponding terminal ratios; but when one of the energy factors has been ascertained by means of a graph, the simpler plan is to find the other factor from the relation $B_t = k_t V_t$.

We have thus ascertained the terminal flux B_t; the terminal P.D. V_t, the flux density β_1 in the central region (for practical purposes the maximum density in the steel), and the flux density β_t at the ends of the magnet, which is B_t/A. To ascertain how nearly the magnet will fulfil the given requirement, we have only to compare B_t with B, and V_t with V. As regards economy of steel, the mean flux density between the extreme values, $\frac{1}{2}(\beta_1 + \beta_t)$, ought not to differ widely from the economic density β_e, nor should the average surplus force V_t/L differ much from the economic value φ_e.

For complete information it is necessary to carry out a fourth integration in about half-a-dozen steps, the starting point being the value of the initial density ascertained as described above. The final integration should result in a terminal flux B_t and terminal P.D. V_t, and hence the terminal ratio B_t/V_t will have the required value k_t.

(To be concluded.)

Telephone Repeaters.*

By B. GHERARDI and F. B. JEWETT.

(Concluded from p. 573.)

Balancing Artificial Lines.

Assuming that the lines have been made as uniform electrically as is economical, there is the problem of constructing artificial lines (or "networks") which shall have within a desired degree the same impedance as the actual line. These artificial lines do not need to have transmission characteristics corresponding to the actual lines, but only the same impedance characteristics. A very simple form is that used in balancing a non-loaded open wire line, consisting of a single resistance in series with a single capacity. A better approximation for a non-loaded open-wire line can be made by adding another resistance and condenser as shown in Fig. 15.

For loaded lines it is necessary to use a somewhat more complex artificial line, although here again the basic form is comparatively simple. Fig. 19 shows in light lines, for comparison, an impedance curve much like that of Fig. 18, and in heavier lines, the impedance of an artificial line consisting of two condensers, a resistance and two inductance coils arranged as indicated by the diagram in this figure. Both the resistance and reactance of the impedance are shown.

The impedance of a loaded line depends markedly on the place in the loading section from which the circuit is measured. In practice, lines are generally terminated either at mid-section or at mid-coil, since these points are symmetrical points in the loading and make for maximum flexibility in connecting circuits together. The

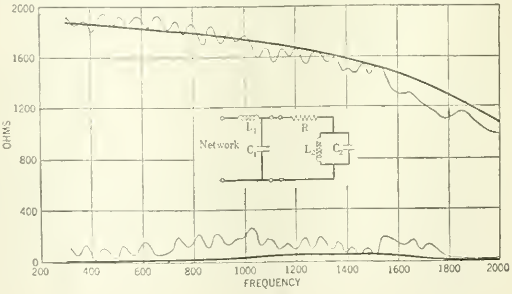

Fig. 19.—Loaded No. 8 Gauge Open Wire Line ½ Coil Termination

balancing line should balance not only the actual line itself, but any apparatus between the line and the point at which the repeater is applied, such as composite sets or other devices used in series with the line.

Tandem Operation of Repeaters.

The operation of a single repeater in a circuit has been discussed. Where several repeaters are used in tandem at different points in a circuit there is a further consideration. Not only can circulating currents be set up, involving each repeater by itself (which may lead to "howling" or to distortion in quality), but such circulating currents may follow paths involving any two or more of the repeaters operating in conjunction. The 22-type circuit, involving artificial balancing lines, has a large advantage over the 21 type for tandem operation, due to the fact that transmission entering it from either direction does not cause a large amount of energy to be thrown back in the same direction. There is thus very much less interaction between the repeaters with the 22 type. Effective tandem operation of repeaters thus requires a high degree of electrical uniformity, and also that the reflection effects between the repeaters and their connected lines shall be reduced as much as possible.

The Four-wire Circuit.

In the above we have considered the application of repeaters in ordinary circuits in which the same pair of wires is used for transmission east as is used for transmission west. It is evident that there would be considerable advantage in transmission if separate pairs of wires were used for transmission east and for transmission west. A circuit of this type, designated as a "four-wire circuit," is shown diagrammatically in Fig. 20.

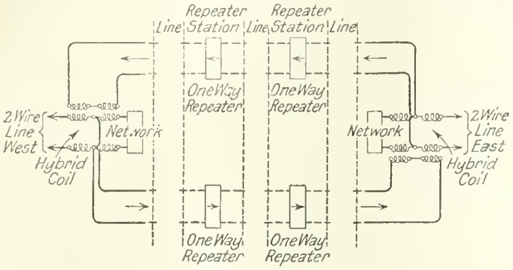

Fig. 20.

The term "four-wire" does not mean necessarily that four wires are used, but that different circuits are used for transmission east and transmission west. Each of these circuits may comprise a pair of wires, or may be a phantom circuit, &c.

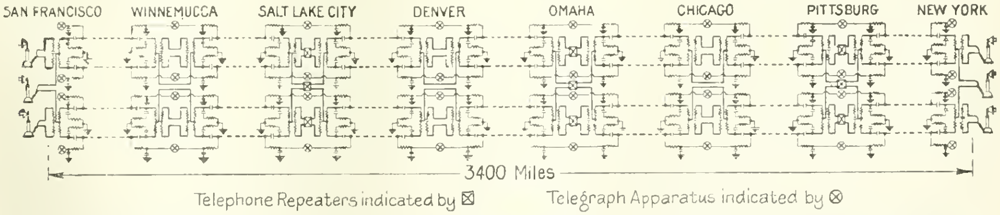

Fig. 21.—New York-San Francisco Circuit when Set up for through Telephone and Telegraph Circuits. (Simplified diagram.)

Line wire. No. 8 B.W.G. copper.
Inductance of side circuit loading coils .... 0·25 henry.
,, phantom ,, ... 0·15 ,,
Spacing of loading coils .... 8 miles.
Line equivalent .... = 56 miles of standard 19 ga. cable.
Apparatus loss .... = 7 miles of standard 19 ga. cable.
Total equivalent .... = 63 ,, ,,
Total repeater gain .... = 42 ,, ,,
Resultant equivalent ...... = 21 ,, ,,

This circuit provides for three simultaneous telephone conversations between New York and San Francisco. At the same time it provides for four telegraph messages in each direction.

In a circuit of this kind there will be one-way repeaters in each of the two branches. The two branches must be brought together at the ends for connection to two-wire lines, or to the subscribers' loops. There is, therefore, a possibility for circulating currents to be set up flowing over the two sides of the circuit in series. In order to minimise such circulating currents, artificial balancing lines are used at the points where the four wire connects to the two wire in a manner similar to the arrangement of the 22-type circuit. If the total amplification of both branches of the four-wire in series is less than the total transmission equivalent, the circuit cannot "sing." If the balance at the ends is good, the gains may be even greater than the transmission losses without producing singing. As in the case of two-wire operation, however, large distortion may be brought into the circuit by the circulating currents even when the amplifications and balance are not such as to produce singing.

Circuits of this kind evidently use twice as many wires as ordinary circuits. They permit, however, the use of smaller wires. For long-distance cable operation, and for other special cases, there are conditions where we find that these four-wire circuits have a field of use.

Method of Applying Repeaters.

In the practical operation of repeaters there are two methods of connecting them into lines which have come into general use. There are :—

(*a*) "Through line repeaters" ; (*b*) "cord circuit repeaters."

The through line repeater is one which is associated with a particular line connected directly into it, and therefore not under control of the operator. It is generally set to give a definite amplification, depending on the characteristics of the line.

The cord circuit repeater is connected into a cord circuit under the control of an operator. The two ends of the circuit generally appear before the operator as two plugs which she may connect into any pair of circuits terminating before her which are in proper shape for repeater operation. The amplification given by the repeater is generally under her control, the amplification in each case depending on the pair of circuits which is connected together.

Practical Results Obtained.

The gain obtained in any practical case now depends almost entirely on the degree of electrical "uniformity" which it is economical to maintain in the telephone circuits to which the repeaters are connected, since we can obtain within practical limits as large amplifications in the repeater elements as we desire. This electrical uniformity requirement has had a great effect on the design of loading coils, and on practices with regard to their use. Almost every feature of open wire and cable construction and office equipment which affects the electrical characteristics of the circuits has been in some way affected by this repeater requirement.

At the present time more than 1,000 telephone repeaters are in service in the plant.

Transcontinental Line.

The circuit over which transmission is given between the cities along the eastern coast and the Pacific coast cities is shown diagrammatically in Fig. 21. Originally there were three repeaters used in this circuit, located at Pittsburgh, Omaha and Salt Lake City. Since that date, largely for flexibility in switching traffic, the number has been increased to six, located at Pittsburgh, Chicago, Omaha, Denver, Salt Lake City and Winnemucca. The total gains were only slightly increased by the change. The circuit consists of No. 8 B.W.G. copper conductors loaded at eight-mile intervals with coils of one-fourth henry each. This gives a line equivalent of 56 miles of standard 19 gauge cable. There is a further transmission loss due to composite and other apparatus of about 7 miles, the total equivalent being, therefore, about 63 miles. This is reduced by repeaters to a resultant equivalent of 21 miles, which is, therefore, about one-third of the equivalent without repeaters. The diagram shows the important points on the line, indicates the positions of telephone and telegraph repeaters, and indicates the compositing apparatus used in separating the telegraph and telephone currents.

Boston-Washington Cable.

The largest use of repeaters on cables has been in connection with the circuits between the various cities which are served through the underground cable route extending from Boston through Providence, Hartford, New Haven, New York, Philadelphia and Baltimore to Washington. The use of repeaters on small gauge cables placed in this subway became of the greatest importance during the war in caring for the tremendously increased requirements for telephone facilities between these large cities along the Atlantic seaboard.

Most of these telephone repeaters are located in the large cities along the route of this cable. At two places, however (Princetown, N.J., and Elkton, Md.), the repeater requirements were such as to justify the putting up of buildings especially for repeater operation.

The longest cable circuits set up along this route are those from Boston to Washington, a total distance of about 455 miles. A typical layout for a circuit of this kind consists of loaded conductors, No. 10 B. & S. gauge from Boston to New York, No. 13 gauge from New York to Philadelphia, and No. 10 gauge from Philadelphia to Washington. This circuit has an equivalent of about 30 miles of No. 19 gauge standard cable, which, by means of repeaters at Hartford and Philadelphia, is reduced to about 14·5 miles. It should be noted here that No. 10 gauge conductors are somewhat larger conductors than would now be placed for this business, and are being used because they were available, having been placed before the use of repeaters had been developed to their present effectiveness.

The longest circuits electrically—that is, those having the greatest attenuation—which have been operated with repeaters along this route are New York–Washington circuits, consisting of No. 19 gauge cable loaded with coils of about one-fourth henry inductance, spaced at intervals of about 1·16 miles. The distance is about 225 miles. This gives a line equivalent of about 62 miles standard cable. By the use of four repeaters at Princeton, Philadelphia, Elkton and Baltimore, the equivalent of this circuit is reduced to about 13 miles of standard cable.

The above circuits make use of the 22 type repeaters. Where there is but one repeater in a circuit, however, the 21 type gives, under many conditions, satisfactory service. For example, between New York and Philadelphia, a distance of about 90 miles, a group of circuits is being worked on No. 19 gauge conductors, with a single 21-type repeater at Princeton. The circuit without repeaters has an equivalent of about 24 miles of standard No. 19 gauge cable. The repeater reduces this to about 14 miles.

A Modern Power Station and Its Development.*

By J. S. WATSON.

An introductory account is given of the development in generating plants installed by the Newcastle-upon-Tyne Electric Supply Company, Ltd., which was the first statutory undertaking to supply electricity on a large scale for motive power to manufacturers and industrial users in the United Kingdom. The total period of 29 years is divided into four stages, as follows:—

First: 1890 to 1899. Lighting supply of slow growth—viz., 155 kw. per annum. Small units, averaging 200 kw. each.

Second: 1899 to 1906. The beginning of motive power supply with more rapid development—viz., 5,057 kw. per annum. A large increase in the size of unit, averaging 2,453 kw. each.

Third: 1906 to 1912. Very rapid development combined with the utilisation of waste power supplies. A yearly increase of 11,942 kw. made up of a large number of relatively small units averaging 2,310 kw.

Fourth: 1912 to 1919. A period of plant reconstruction and increased power demand, requiring an average installation of 9,714 kw. per annum, the growth being met periodically by installing units averaging 11,330 kw. each.

Technical Characteristics of the Various Stages.

—	Stage 1.	Stage 2.	Stage 3.	Stage 4.
Location of power stations	Centre of residential area	Centre of industrial area	Coal-fired stations on riverside and waste power closely adjoining coke ovens or blast furnaces	Centre of industrial area and on riverside
Boiler-house plant..	Lancashire	Water tube	Water tube	Water tube
Evaporation per boiler	6,000 lb. per hour	14,000 lb. per hour	28,000 lb. per hour	45,000 lb. per hour
Steam pressure	120 lb. per square inch	200 lb. per square inch	200 lb. per square inch	270 lb. per square inch
Steam temperature	350° F.	481° F.	531° F.	675° F.
Coal and ash handling methods	By cart and hand	By rail and hand	By rail and conveyor	By rail and automatic plant
Engine-room plant	Slow speed, cross compound horizontal with rope drive to generators	Slow speed, triple expansion marine type direct coupled to generators	Reaction turbines direct coupled to generators	Reaction turbines direct coupled to generators
Generators	Disc-type, single-phase, 100 periods, 2,000 volts	Revolving field, 3-phase, 40 periods, 5,750 volts	Revolving field 3-phase, 40 periods, 5,750 volts	Revolving field 3-phase, 40 periods, 5,750 volts
Revolutions per minute ...	85 revs. per min.	100 revs. per min.	1,200 revs. per min.	2,400 revs. per min.
Switchgear	Plug type, grouped feeders. No paralleling arrangement	Cellular type, air break switches. Parallel operation	Cellular type, oil break switches of large size, Parallel operation	Cellular type, oil break switches of large size. Parallel operation

Plant in the various stages was superseded and scrapped, not because it was worn out or had become materially less efficient in operation, but because other much more efficient plant had been developed, and it no longer paid to run the old plant.

The above table gives further salient features of the various stages.

Remarks on the Various Stages

The station was originally situated in the centre of a residential district in the city of Newcastle, and supplied single-phase current. All coal and ashes had to be dealt with by hand, and were carted to and from the station. The condensing plant consisted of ejector-type condensers worked in conjunction with spray ponds for cooling purposes. The plant was not arranged for parallel running, and the supply was momentarily interrupted when changing machines or grouping of feeders, or when adding to the number of machines in service. The efficiency of the plant, moderately good at full load, fell off rapidly when the loading of each set was reduced.

The difficulties in coal delivery, the nuisance caused by cooling-pond vapour, and the growing load and the demand for electricity for power purposes, for which single-phase supply was unsuitable, necessitated the step to the second stage.

The power station was now located near the river in the industrial area, and three-phase current at 5,750 volts permitted transmission to distances sufficient to embrace the whole of the company's area of supply.

Coal deliveries were made direct by rail to the boiler house, but the transfer from floor to boiler was still made by hand. Similarly, ashes were dealt with by hand to a bucket elevator. The site did not allow the use of an unlimited supply of circulating water, and cooling towers had to be provided.

The improvements were justified by a reduction in cost, followed by increasing demands for industrial purposes, and it became necessary to install further plant. It was decided to install a 2,000 kw. turbo-generator—*i.e.*, of three times the capacity of the individual units already in commission. This step involved more perfect condensing water arrangements; a power station was accordingly erected on a riverside site ("Carville A") at Carville in 1903.

The first instalment of plant amounted to 12,000 kw., and was eventually increased to 43,000 kw. This is still a most important source of power, although it has, in a matter of economy, been largely superseded by the more modern power station described hereafter. The utilisation of the waste heat in connection with the working of coke ovens and blast furnaces now received attention, and the third stage of development was entered.

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* Abstract of a Paper read before the North-East Coast Institution of Engineers and Shipbuilders.

In this stage the location of the stations, other than the coal-fired stations, was decided by the position of the coke-oven or blast-furnace plant from which the waste power could be obtained, and it was necessary in most cases to use cooling towers. These stations varied from 1,000 kw. to 5,500 kw. The plant consisted of water-tube boilers working at a pressure of 200 lb. per square inch, and turbine plant coupled direct to three-phase 5,750 volts 40 ∾ alternators running at 1,200 to 2,400 revs. per min. The turbines consist either of high-pressure or exhaust steam plant depending on the class of power available. The station runs at the maximum capacity possible, any variations being met by the larger coal-fired stations. The waste-power stations run continuously except for periods of overhaul.

Continued demands for the supply of electricity for all purposes—chemical, industrial and coal mining—necessitated the provision of further generating plant, with the result that the fourth stage was arrived at. It was decided to erect adjacent to, but distinct from, the existing station, except as regards electrical connection, another of 50,000 kw. capacity (Carville "B"). This is the latest station, and shows a further marked improvement in economy. The two boiler houses lie at right angles to the engine room. Each house contains two banks of three, three-grate, water-tube boilers, each complete unit consisting of boiler, superheater and economiser, and capable of evaporating 45,000 lb. of water per hour, when burning coal of 9,000 to 11,000 B.T.U. calorific value, at a pressure of 270 lb. above atmosphere and superheated to 675°F. from water supplied at 90°F. The use of outlet gases raises the feed water to about 220°F., such outlet gases leaving the economiser at about 350°F. Mechanical draught, both forced and induced, enables coal of low grade to be burnt. The air heated by use for ventilating the alternators is delivered by the ventilating fans to the forced-draught fans, whence it is discharged to the furnace. This results in a slight gain in efficiency.

The arrangement of the boiler-house building provides ample space for cleaning and repairs. Each stoker can be withdrawn without seriously affecting the operation of the boiler opposite to it. Coal is delivered by an overhead siding to receiving hoppers provided with coal crushers, and filling plant for feeding the bucket conveyor; this delivers direct into coal bunkers forming the central roof of each boiler house. Thus, two different grades of coal can be crushed, thoroughly mixed and delivered to the boilers.

The coal is fed to the chain grates by gravity through coal chutes. Refuse is dumped into ash pits at the back of the boiler, which discharge direct to the suction ash-handling plant installed in a basement. A close check being kept upon the efficiency of the plant, which, with the higher calorific value of the coal mentioned, amounts to 85·5 per cent.

The engine room, 183 ft. long by 83 ft. wide and 65 ft. high, contains five three-phase 5,750 volts 10,000 kw. 40 ∾ turbo-alternators, running at 2,400 revs. per min. Each machine is complete with a direct-coupled exciter, condenser, turbine-oil cooler, oil filter and air filter. The horizontal reaction type Parsons turbines are provided with high and low-pressure cylinders. The surface condensing plant, placed immediately below the low-pressure cylinder, consists of twin condensers connected in parallel bolted. Thus, one condenser at a time can be cleaned without taking the machine out of service.

The air-extracting plant consists of a steam jet and augmentor in series with a totally-enclosed reciprocating pump. The plant as a whole can maintain a vacuum of about 96½ per cent.

The rotary feed pumps driven by steam turbines are the only steam-driven auxiliaries in the station; exhaust steam from these pumps is discharged into the hot well.

The alternator is of the rotating-field type with direct-coupled exciter, is totally enclosed and is fan ventilated. A special feature is the water cooling of the rotor by pumping through tubes placed at the bottom of the slots in the rotor with a special cooler in circuit for cooling the water. Circulating water for the condensers is provided from a pump house at the river, 130 yds. from the station. Each pump, electrically driven, can deliver 16,500 gallons of circulating water per minute against a total head of 55 ft.

The high-tension switchboard occupies four galleries. The two upper galleries contain the 'bus bars. The operating gallery contains the main oil switches and the operating panels, the bottom gallery instrument transformers, &c. All cables run in a straight perpendicular line from the bottom gallery to the 'bus bars, passing through their respective switch. The whole of the frame work of the chambers and partitions is of concrete, and everything has been done to isolate any trouble which may arise. The main high-tension oil switches are electrically operated from a distance, the operating panels being grouped so that the attendants may have all necessary regulation under control.

The station is the most efficient in this country—probably in the world. The characteristic changes comprise (*a*) the increase in boiler pressure; (*b*) the increase in steam temperature; (*c*) the higher speed of plant (consistent with the periodicity of the system); (*d*) the large individual size of generating units; (*e*) the more complete utilisation of labour-saving appliances.

The methods adopted for the control of the running of the various stations are also of interest. The whole of the plant feeds into a common network of cables throughout the north-east coast area, upon which most of the industries of the area depend. The load is a very variable one, and the plant installed is of varying efficiency. Hence the employment of control engineers, one or more of whom are continuously on duty.

The author concludes the Paper by a summary of data for the various stations and a diagram of the latest ("Carville B") plant. The total installed capacity is now 186,450 kw., dealt with by 18 stations, of which four operate by coal firing, three by coal firing and coke oven gas, three by waste heat from coke ovens, and eight by exhaust steam from blowing engines. Boiler pressures vary from 120-270 lb., steam temperatures from 350°F.-675°F., capacity of machines from 267-10,000 kw., and engine and turbine speed from 85-2,400 revs. per min. Finally, the steam consumption varies from 28·5 down to 10 lb. per kilowatt-hour, the kilowatt capacity per square foot occupied from 0·3 kw. to 15 kw., and the kilowatt capacity per man engaged from 141 kw. to 633 kw.

The station thus offers an interesting example of progressive development towards the most efficient condition, as represented in the latest section known as "Carville B."

Reviews.

Hydro-Electric Power Stations. By B. Rushmore and E. A. Lof. (London: Chapman & Hall.) Pp. x.+822. 28s. net.

This is an important book dealing with the whole range of problems involved in hydro-electric supply, the ground being very completely covered and the nature of the information given being of the kind that is actually needed by the engineer having such work to carry out. The authors state that their object is not so much to provide a treatise on the details of design as to put before the student and operating engineer a broad explanation of the problems involved in the construction and management of hydro-electric stations, which, owing to augmented demands for energy and shortage and high cost of fuel, are of increasing importance. They aim also at providing hitherto unpublished information in regard to recent practice. These aims have been realised and the result is a thoroughly practical treatise logically, clearly and consistently arranged. A particularly useful feature is the illustration of the principles enunciated by typical actual examples of works carried out which are shown both by dimensioned drawings and by photographs of the completed plant or structure. This method gives an extraordinary sense of reality to the descriptions and greatly enhances the value of the book. The diagrams are clear and easily understood. The authors give numerous useful formulæ, with the necessary constants when they are empirical, but they do not attempt to go into the theory from which such formulæ are derived. The result is the assembly in a moderate space of much information of practical value. The tables are numerous and very useful.

There are eleven chapters in all, with three appendices. After a general introduction, a sketch of water-driven prime movers and of electric transmission and power, the amount and distribution of water power especially in the United States, including that derivable from inland waterways, the demand for power and its application, and the present distribution of the demand among the various classes of prime mover are referred to. Next follows an examination of the commercial opportunities for the applications of hydro-electric power.

In Chapter II. the authors deal with the physical properties of water, the characteristics of rainfall, its subsequent disposal and the means of measuring stream flow. The next two chapters are concerned with the classification of schemes according to the height of head available and with the construction of dams of various kinds and their flash boards, and of intakes. The fifth chapter goes into the question of the various means of conveying water and of the avoidance of water hammer. Gates and valves are fully treated. Chapter VI. deals with storage reservoirs. In Chapter VII. power-house design is considered in all its aspects, including the general design of the building, the arrangement of the plant, the means of bringing such plant on to the site and erecting it, and finally the precautions to be taken in starting up the station. In Chapter VIII. the various types of turbines and their characteristics are considered, the means of governing them and of regulating the water pressure on them. This chapter concludes with water-flow meters and water-stage registers.

Chapter IX. is of such length as to constitute nearly half the book, and deals with the electrical equipment. After general considerations there are treated in succession synchronous generators, induction generators, exciters, pressure regulation, transformers, current limiting reactors, switching equipment, protection against excess pressures, and finally the wiring of the station. It is impossible to refer to these matters in detail, and it must suffice to say that they are all dealt with from an eminently practical point of view without shirking the difficulties and in a manner that gives the engineer an intelligent grasp of the questions at issue, though obviously they cannot take the place of more extended treatises on the various matters involved. Chapter X. goes on to consider the economical aspects of the matter, and embodies the guide drawn up by the Hydro-electric Engineer of the Canadian Water Power Department for the compilation of water power reports and field data. This is a valuable and suggestive document and may be studied with benefit. The influence on the financial aspects of a scheme of the amount of energy available, the demand for power and the nature of the load, the question of water storage and of auxiliary stations are all in turn considered as well as the inter-connection of systems. The various points to be looked for in investigating an enterprise and the cost of establishing one are gone into in detail as well as the cost of producing the power. The book concludes with Chapter XI., which is devoted to organisation and operation. Appendix I. enumerates the various American hydro-electric power stations; Appendix II. gives the principal data of transmissions operating at 70,000 volts and above; Appendix III. gives the standard American testing code for hydro-electric turbines.

The book is well printed, well illustrated and well bound, and has very few printer's errors. The English jars somewhat in places, such expressions as "Concentration of such enormous amounts of power *which* are now generated," "a long number of years," "from where," "they tend however *as*," "to speed up some," are met with; examples of careless writing are: "The specific heat of water is greater than all known substances," "The diagrams . . . . was based," while fractured infinitives abound. These are trivial blemishes on a work that can be confidently recommended.

C. H. Wordingham.

Electric Power Transmission. By Prof. Alfred Still. Second Edition. (London: Hill Publishing Company.) Pp. xviii. + 407. 17s. 6d. net.

The first edition of this book, published six years ago, was limited to overhead work; the present edition includes also transmission by underground cable, and is mainly based on American practice. This in itself is a guarantee of the practical value of the book, and, when combined with the clear and common-sense methods of exposition characteristic of the author's style, it will be readily admitted that he has produced a most useful book.

As in the first edition, the author leads off with an introductory chapter dealing with the general principles of transmission, but in more detail and with reference to more recent developments. We learn that the operating voltage has now increased to 150 kv., and the magnitude of plant to an ultimate capacity of 300,000 kw., the distance to 240 miles and the limit of power carried on one single three-phase line to 30,000 kw. As regards cables, the author puts the limit of pressure at 45 kv., which is considerably higher than English cable makers consider advisable. The popular belief that only high steel towers spaced about eight to the mile are being used in long-distance high-power transmission is not borne out in practice; we learn that the total mileage of lines working above 50 kv. is about equally divided between steel and iron supports. In the author's opinion, legislation in England has in the past "been generally unfavourable to the development of electric transmission," and our Board of Trade comes in for some adverse criticism on the high factors of safety (10 for wood, 6 for steel and 5 for lines) prescribed. In the author's opinion, lower factors, but supports of the "flexible" type, would be preferable. What the author has to say in this introductory chapter on the financial side of the undertaking is well worth reading. He shows that it is not always the system which requires the minimum of material and that of the cheapest type that pays in the end; climatic and topographical conditions, facility of transport, ease of supervision, loss by corona and ohmic heat, and, above all, continuity of service, which depends not only on sound construction but on quick localisation of faults and their repair, have to be carefully studied if the undertaking is to prove a financial success.

In the second chapter we enter into the theory of transmission. There is little change from the first edition. We find the usual vector diagrams as given in any good text-book, and we also miss what other text-books so carefully avoid—namely, the vector diagram of a two-phase plant with a common return the impedance of which cannot be neglected. It is quite true, as the author says, that three-phase plant is far more important and in every way better; but there are some two-phase plants in use, and the engineer who has to work them knows that the impedance of the common return introduces some very disturbing features. The phases are forced out of quadrature, and they are not equal as to magnitude, loss and power factor, all of which is bad for the motors. Here would have been an opportunity for the author to show us how, by applying vector analysis, the exact working conditions can be determined, and possibly how a remedy for the defects of the system can be found.

The economic principles are dealt with in Chapter III.

Choice of system and type of line, length of span, duplicating lines, Kelvin's law, economic voltage, annual charges and depreciation, cost of energy wasted and other matters influencing cost and revenue are exhaustively dealt with. In discussing such matters actual prices must be used, and the author has used pre-war prices both for materials and labour, leaving it to the reader to adjust his tables to actual conditions. In the following chapter we come to the calculation of lines considered merely as conductors—that is, apart from insulators and supports. Some very useful tables and diagrams are given on the mechanical properties of steel, copper and aluminium, skin effect, inductance, capacity, voltage drop and other matters influencing the pressure and power factor at the delivery end. On p. 116 is given a diagram showing how by inserting an alternating-current booster in the middle of the line the resistance drop at the far end may be reduced by half. The booster is driven by an over-excited synchronous motor, which thus acts as phase advancer. It is not stated whether this plan is only a suggestion of the author or has actually been put into use.

About 120 pages are devoted to the statics of transmission lines and their supports. It will thus be seen that the subject is treated very thoroughly. For horizontal spans the usual parabolic formula is used, but for sloping spans a more complicated formula becomes necessary. The influence of ice and wind is fully discussed, and, to facilitate calculation, curves are given both for aluminium and copper, connecting wind velocity and diameter of wire. The different types of masts and towers are fully discussed and illustrated, some by dimensioned drawings, so that this part of the book will prove useful, not only to the electrical engineer, but also to the civil engineer, whose business it is to design such structures.

Cables are discussed in Chapter VII. In the author's opinion, it is possible that, especially in connection with Swiss railways, power up to 20,000 kw. will be transmitted through single-phase cables at pressures of 80 kv. or even 100 kv. He mentions as an appropriate instance the Dessau-Bitterfeld single-phase line, working at 60 kv., with two 30 kv. cables, the middle point being earthed through a resistance. Tables are given for cost of cables and laying under different conditions. The author states that a cable line is always more expensive than an overhead line, but for limited distances, such as prevail in this country, may prove cheaper in the end. About 30 pages are devoted to protective devices, such as arcing rings, water jet, multi-gap and horn type arresters, condensers, aluminium cells, choking coils and other appliances.

A short chapter is devoted to the Thury system, and it is interesting to note that Prof. Still is not disinclined to admit the possibilities of this system. It will be remembered that the late Lord Kelvin was one of its advocates, and even so convinced an alternating-current man as the late Mr. Dolivo-Dobrovolsky published a few months before his death an article in which he stated that the future of long-distance transmission lies with the continuous-current series system. Prof. Still does not go so far; but, at any rate, he appears to have an open mind on this question.

The appearance of this book at a time when the mind of the industrial world is set on electrification of industries and their reconstruction is exceedingly opportune. The author has produced an excellent volume on a most important subject, which will be useful alike to the student and the practical engineer.

GISBERT KAPP.

Correspondence.

PREDICTING MAGNETIC STORMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With a view to answering Mr. Orme Bastian's letter in your issue of September 19th last, I have consulted the diaries of the Midland Railway Telegraph Office here for records of disturbances of telegraph circuits by earth currents or magnetic storms, and have charted the dates of all the planetary oppositions and, so far as records are available, of disturbances since the commencement of 1909. Now that the oppositions of Neptune, Jupiter and Saturn looked forward to by Mr. Orme Bastian have passed (as also an opposition of Mars on April 21st), a comprehensive reply to his letter may be given.

There is no record of a storm coinciding with the opposition of Jupiter in September, 1915, but there was a disturbance affecting telegraph circuits on August 9th, 1917. I cannot answer the question respecting October 8th, 1909. The anticipated magnetic phenomena from January 31st to February 3rd, 1920, did not appear. The first considerable storm of this year was on March 22nd, 23 days after the opposition of Saturn, and 30 days before that of Mars. That storm, therefore, cannot fairly be connected with any planetary position; and it is evident that magnetic disturbances do happen independently of oppositions.

There were, indeed, storms in August in each of the last four years within a fortnight of the (practically) annual opposition of Uranus; but it has long been observed in telegraph operation that "earth currents" are most prevalent at the break-up of the seasons, that is, at the ends of summer and of winter, so that it is most probably a mere coincidence that recent August disturbances appeared about the date of Uranus' opposition.

If there be an electronic stream directed, as distinguished from radial emanantion, from the sun to each of the planets, there will be one to our own planet, and if such streams are subject to deflection by the Perseids that to the earth should be affected by the meteor stream which we always encounter in August. Without at all committing myself to either theory I would favour the idea that the Perseids, rather than the position of Uranus, may account for August disturbances.

Conjunctions do not touch Mr. Orme Bastian's theory because the earth can never be between the sun and the planet when the latter is in conjunction with the sun; but at their inferior conjunctions Mercury and Venus come nearly between the sun and the earth and might then be suspected of interfering with the supposed earthward stream. In 1918 there was an inferior conjunction of Mercury on April 27th and a magnetic storm on April 30th; another on September 2nd, midway between the storms of August 15th and September 21st; a third on December 18th, three weeks after the storm of November 28th. An inferior conjunction of Venus on February 10th, 1918, cannot be associated with any disturbance as none is recorded before April 30th in that year. On the whole the evidence is against any effect being produced by conjunctions.

I am of the opinion that "magnetic storms" may be due to two causes, (1) Solar, when outbursts of solar energy (evidenced by large sun spots) radiate through space causing inductive effects in wires; and (2) Terrestrial, when meteorological conditions cause the earth to assume different potentials at different points. Of the last 19 disturbances 14 occurred in the evening averaging less than an hour's duration. That of March 4th, 1920, affected our telegraphs during only 15 minutes.—I am, &c.,

Derby, May 20th. G. EDMONDSON.

THE EMPLOYMENT OF GEARED TURBINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the Editorial Notes of your May 14th issue, you state that "at present our experience of geared turbines is hardly sufficient for their universal employment to be recommended." We cannot think that in making this statement you know to what extent gearing has so far been used. Up to date, we, who are only one of the several firms manufacturing large geared turbines, have supplied and are building approximately 50,000 H.P. in 60 units for mill-driving, blowers and pumps, and 100,000 kw. in 79 units for driving electrical machinery. The supply of these units has extended over a period of ten years, and we have confidence in saying that experience has proved that large geared turbo units can be safely adopted and be fully recommended.

Apart from the above-mentioned machines, surely the use the Admiralty have made of geared turbines is sufficient to indicate that such plant is far beyond the experimental stage. The total horse-power of geared turbines installed in ships now exceeds 16,000,000 H.P. You will appreciate that reliability is of prime importance on board ship as in mills, where, in most cases, the whole mill depends only on this form of prime mover. I am, &c.,

FOR C. A. PARSONS & COMPANY, LTD.,
Newcastle-on-Tyne, A. R. CARNEGIE.
May 27.

TELENDURON v. PORCELAIN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There has recently come into my hands a brochure, published by Thos. de la Rue, upon a composition insulator named "Telenduron," in which brochure this material is compared with porcelain, to the disparagement of the latter.

It is granted, of course, that almost any composition material is less brittle than porcelain, though good English porcelain is much tougher and resistant to breakage than many people imagine, more especially when the porcelain is fairly thick, as in transmission work. In this brochure, however, porcelain is condemned as depending upon its glaze for its insulation, and upon the failure of the glaze by hair cracks the porcelain absorbs moisture (*sic*). This may be true of rubbish, mostly foreign, styled porcelain, but it is surprising that it should still be necessary to inform some people that proper English porcelain as made by reputable firms for the purposes mentioned (all of which porcelain is made by the wet process) does not depend upon the glaze for insulation, the porcelain being vitreous and homogeneous, the glaze being added merely for finish and possibly colour.

"Telenduron" is set up as being non-hygroscopic and of marked superiority to porcelain, but this is not corroborated by the tests which they publish, made by the National Physical Laboratory, as shown in the following comparison.

Tests on Post Office Small Insulator.

	Telenduron.	Porcelain.
Flash over voltage, dry	40 kv.	70 kv.
Puncture voltage	25 kv.*	At least 75 kv.
Absorption	0·1 to 0·3 p.c.	Immeasurably small; certainly below 0·01 p.c.

Whatever advantage this material may have in respect to lesser liability to breakage is obtained, therefore, at the expense of its electrical characteristics. This, no doubt, is justified in many cases, but I note that in their covering letter Messrs. de la Rue make reference to the use of this material for high voltage transmission work. In this connection, electrical considerations are the primary considerations, and all others are secondary.

Then there is the question of durability, having regard to the deleterious atmospheric conditions obtaining in some manufacturing districts in which insulators have to work. No tests are given here, but in this respect a composite material (which often incorporates vegetable and animal substances) can scarcely be expected to compare with porcelain which is made from rocks of the earth itself. I am, &c.,

Per pro TWISS ENGINEERING &
ELECTRIC TRANSMISSION, LTD.
London, May 26. GEO. V. TWISS, M.I.E.E.,
Managing Director.

THE ENGLISH DOCTOR OF PHILOSOPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. J. Butler Burke, in his article, "The English Doctor of Philosophy," talks of the "popularity" of the teaching profession, and attributes it primarily to lack of initiative or resource, natural indolence or the absence of the spirit of adventure which induces the path of least resistance to be chosen!

Teachers of scientific and technical subjects will join me, I am sure, in strongly resenting "superior" talk of this kind. The teaching profession, so far from being popular, is having a very great difficulty in attracting men to its ranks, and this is nowhere so evident as in the scientific and technical branch.

If indolence and lack of initiative be the causes which induce men to choose the teaching profession, then these men must receive a very rude awakening when they find that indolence cannot be indulged, and that initiative and energy are necessary attributes of the teacher.

It is somewhat astonishing that Mr. Burke appears to know so little of the needs of the teaching profession, and that he appears to labour under the old delusion that teaching is a "soft job" in which a man may idle away his days and enjoy long vacations which are unnecessary. Surely, Mr. Burke knows better than this; and if he does not he would have been well advised to have obtained some knowledge of the labour of teaching before he slandered a body of men whose work is more vitally essential to progress than that of any other body of workers.—I am, &c.,

Poplar, May 25. J. PALEY YORKE.

ENGINEERING AND ADVENTURE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of April 23 you were kind enough to praise an article of mine on "Engineering and Adventure," which appeared originally in the "Engineering News-Record," of New York. You expressed surprise that a teacher of an academic and dry-as-dust subject (I am assistant professor of English in the College of Engineering of New York University) should "show familiarity with the broad trend of thought of engineering minds," and should condemn the over-dose of system from which the world has been suffering.

Will you permit me to explain that I have some understanding of, and sympathy for, engineering because I received an engineering education, and have worked at engineering journalism on the editorial staff of the "Mining and Scientific Press," of San Francisco, under the direction of Mr. T. A. Rickard, formerly editor of the "Mining Magazine," London. One or two engineering colleges in this country are starting the policy of having an engineer who has himself written technical articles teach English to engineering students. This, perhaps, explains why a professor of English discussed engineering in such a manner as to cause you surprise. Also it marks a considerable innovation in higher education, where innovations are notably scarce. I am, &c.,

New York, May 11, 1920. PHILIP B. McDONALD.

Heating and Cooking Notes.

CRESSALL WATER BOILING APPLIANCES—ELECTRIC STERILISERS.

In hospitals and in surgery practice generally electric sterilisers have proved to be a popular piece of apparatus, and for several years past the design has been such that very little trouble has been experienced with their use. The dental profession, though quite closely allied to surgery, does not seem to have so quickly appreciated the advantages that electrical sterilisers offer, and one finds many dental surgeons where electric lighting is employed, but water for sterilising purposes is heated by gas. This may be due to the employment of gas in connection with the melting of dental materials, a condition which is quite likely to alter as the smaller electric furnace becomes more popular.

The CRESSALL MANUFACTURING COMPANY have recently produced a new electric steriliser, the design of which is the outcome of many years experience in making this type of apparatus. The tank, lid and tray are made of stout copper sheet, heavily nickel plated, all corners being rounded to facilitate cleaning. The element is mounted at the base of the tank, and a simple regulating device allows for four degrees of heat to be obtained, full, three-quarter, half, and quarter heat respectively. Full heat will in each case boil the water from cold in 12 minutes, and quarter heat is sufficient to keep the water just below boiling point, ready for instant boiling when required. This apparatus is made in three sizes, the cubic capacities being 96 cubic inches, 480 cubic inches, and 800 cubic inches; with loadings of 600 watts, 1,400 watts, and 2,600 watts respectively. In the majority of cases the smallest size steriliser could be used off any lampholder. The tray indicated in the illustration is the standard pattern, but half-trays or special shaped trays will be quoted for and made where required. The Cressall Company are also willing to supply elements for the conversion of existing sterilisers.

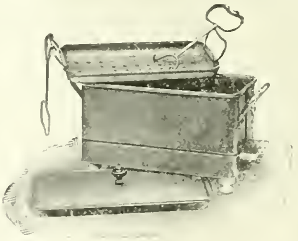

FIG. 1.—"CRESSALL" ELECTRIC STERILISER.

HOT-WATER JUGS.

As a means of having hot water on the table and thus saving journeys to the kitchen the electric hot-water jug or boiler has much to commend itself. The CRESSALL COMPANY are making this

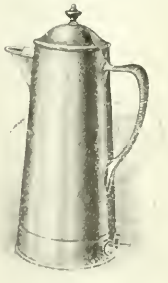

FIG. 2.—"CRESSALL" ELECTRIC HOT-WATER JUG.

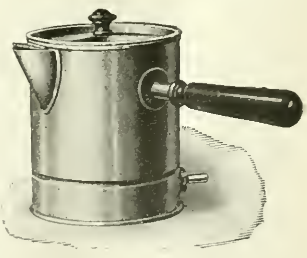

FIG. 3.—"CRESSALL" PORTABLE RAPID WATER BOILER.

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* It is important that the puncture test of any insulator should be greater than the flash over dry. This is so with the porcelain insulator, but as the above test shows, is not so with Telenduron.

class of apparatus in two patterns. The type shown in Fig. 2 has a capacity of 2½ pints, and can be supplied either fitted with a single heat element consuming 90 watts, and suitable for maintaining the temperature of the hot water; or fitted with an element of 360 watts and means of obtaining three-heat regulation, thus providing for boiling the water from cold or maintaining the temperature of the water. These jugs are constructed of stout gauge sheet brass or copper, and finished nickel plated, polished copper, or polished brass.

The portable water boilers shown in Fig. 3 are made of sheet copper, nickel plated, and are offered in three sizes: one, two or three pints, the loading ranging from 360 to 710 watts. As they are intended for quick boiling, heat regulation is not provided for. A four-pint boiler of similar type is also made, having a loading of 710 watts and three heat regulation. The essential difference in design is the replacement of the straight rod handle, with a loop handle similar to that on the hot water jug shown in Fig. 2.

Electric Kettles.

The "Cressall" kettle is made in four sizes, one, one and-a-half, two and-a-half and four pints respectively, the loadings ranging from 350 to 1,050 watts. The element of the four-pint kettle is arranged to allow for four-heat regulation, and at a small extra charge the smaller sizes can be supplied with elements for either three- or four-heat regulation as required. The interiors are hand tinned, and the exterior can be either polished copper or nickelplated. Every kettle is guaranteed for a period of 12 months from the date of dispatch from the works.

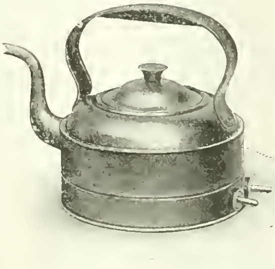


Fig. 4.—"Cressall" Electric Kettle.

University of London.

The ceremony of laying the foundation stone of the new wing of the London School of Economics was performed by the King on Friday last. The new building will be the future teaching and lecture centre for the new faculty of commerce of the University of London, the funds for which have been provided by the Sir Ernest Cassel Educational Trust and other benefactors.

In the course of an admirable reply to the address, which was read by the Vice-chancellor of the University, His Majesty said it was gratifying to note that the University of London, which had grudged nothing of its youth and valour to the armies in the field, had been planning the development of new spheres of usefulness in the furtherance of the fruitful arts of peace. The bad and narrow tradition, which was attacked by Francis Bacon, had long since disappeared, and the circle of academic studies had been steadily enlarged by the pressure of scientific ideas and of practical needs without injury to the claims of a broad and humane education. When estate management, horticulture and commerce were included in the curriculum, a university could no longer be described as a place in which nothing useful was taught. It was right and fitting that the new faculty of commerce should be linked to the London School of Economics, which had for many years enjoyed the reputation of being one of the principal centres of economic inquiry in the Empire, and he regarded it as no less appropriate that a university situated at the very heart of our commercial system should now resolve to turn the dispassionate and illuminating eye of science upon the facts and principles of commercial life. That the establishment of the new faculty should have been assisted by the munificence of London citizens was in accord with the generous traditions of the metropolis, and he trusted that in every well-conceived scheme of improvement the university might rely upon the continuing support and sympathy of the great community whose interests it was more particularly devised to promote. The importance of the University of London was not, however, to be measured by the benefits which it had conferred, or was capable of conferring, upon the students of the metropolitan area. The London degree was valued far beyond the limits of the British Isles. It was becoming increasingly evident that the incomparable advantages which the capital afforded for the pursuit of the higher studies in many departments of knowledge must secure for a university, so organised as to turn to the best account the hospitals and libraries, the museums and art galleries of the metropolis, as well as its vast treasury of economic and commercial experience, a unique and commanding influence in the educational system of the Empire.

Electricity Supply in Holland.

Like other industrial countries, Holland has been badly affected by the high price and difficulty in obtaining supplies of coal. Consequently a national scheme of electricity supply, with a network of high-tension transmission lines covering the whole of the country has been prepared. According to the "Board of Trade Journal," the projected scheme will cost 125,000,000 florins, and it is understood that as Dutch manufacturers are not in a position to tender for all the plant required, a fair proportion of this will be ordered abroad. Already orders amounting to over £1,000,000 have been secured in this country. The existing power stations will be allied with the State scheme, the former being charged with the 10,000 and latter with the 50,000 volt distribution network.

In 1913, the maximum load on the power stations was 45,600 kw., and the total annual consumption 114,000,000 units, but in 1918 the figures were 100,000 kw., and 240,000,000 units. To meet present requirements the Government Committee appointed to report on the question is of opinion that it is necessary to arrange for a total load on the electric power stations of 3-4,000,000 kw., giving a total capacity of 1,000,000,000 units per annum. Such a supply will mean, with an anticipated population of 10,000,000 inhabitants in the next 30 years, a consumption of 100 units per head per annum, against 35-40 at present. This will compare with a present approximate consumption in the United States of 176 units per head, 140 for Switzerland, 60 for England, and 50 for Germany. This estimate does not take into account the electrification of railways, for which it is provisionally estimated that 250,000 kw. will be ultimately necessary.

Immediate Developments.

The construction of the transmission lines for the whole country may take from 5 to 10 years. For the high-tension network three-phase current, 50 cycles, is to be adopted, the minimum voltage being 50,000 The capacity recommended for the stations supplying the system is 30,000-75,000 kw., and each station will be equipped with generators developing 15,000 kw. Legislation is necessary to enable the Government to take over the supply undertakings which are necessary. These are the Geertruidenberg power station with its 50,000 volt lines in North Brabant, and the recently-built power station of Amsterdam municipality. It is also recommended that the construction of high-tension lines should commence immediately as under: (1) Roosendaal-Flushing or Middelburg, (2) Helmond or Uden—South Limburg, (3) Geertruidenberg-Rotterdam-The Hague-Amsterdam, with a branch line to Utrecht, and (4) Uden-Nymegen-Arnhem-Zwolle. The cost of this portion of the scheme is estimated at 35,000,000 to 40,000,000 florins.

It is probable that a special Administration is to be created for the service. Several alternatives have been under consideration, but preference has been given to a State enterprise under which the supply of electricity is to be a direct Governmental service endowed with a large measure of freedom. Working agreements will be made as to the supply of current and the sharing of profits with municipal and companies administering the scheme. A Committee of the Society of Directors of Electricity Supply Undertakings in Holland, which has been investigating the scheme for some time, is preparing a report, parts of which have been issued. The Committee has calculated that for loads of 7 kw. to 20 kw. per sq. km. the stations for transforming the energy from 50,000 and 100,000 volts should be 20 to 30 km. apart. It appears, therefore, that about 50 transformer stations will be necessary for the country, and the average distance apart will be 25 km. Another part of the report deals with the feeding of the high-tension transformer stations, the cross-sections of the lines, &c. The calculations are based on the supposition that the transformer stations are 25 km. apart and are all equally loaded. A number of graphs show that for large but sparsely populated districts a very high voltage is most economical, whereas for heavily-loaded industrial centres a lower voltage is to be preferred. It is stated that the concentration of the generation of electricity has limits, and it will be preferable above, say, 30 kw. to 50,000 kw., to erect more power plants instead of having a heavier high-tension distribution system.

The transmission of electrical energy from the mining district is discussed in a separate section of the report, and it is stated that it is much more profitable to transport the fuel, unless the effective value of this fuel is less than one quarter of the effective value of coal of ordinary good quality. Supplying a part of the country with electricity from the mining district will only be justified if there is a very inferior fuel (brown coal and minestones) in sufficient quantity at hand. As there is no more inferior fuel in South Limburg than can be consumed by the mines in their own power plants, there is no urgent need to build a transmission line for connecting this mining district with the other part of the network. The advantages of centralisation are greater than those attainable by the use of inferior fuel, but there should be advantages in placing the whole generating plant for the mining district under one authority, which would then be able to compete in the electricity supply of the southern part of the country. The mining industries will require large quantities of electricity, and it will be advantageous to concentrate the production in one or more large power plants.

The Development of Reyrolles.

History is at once an example and a warning. From the first we can learn how enterprise and courage in the face of difficulties have brought policies to a successful conclusion, and from the second derive much useful information as to the avoidance of piftalls into which the unwary might otherwise be tempted to fall. The history of Messrs. Reyrolles, Ltd., which firm is now about to celebrate its twentieth birthday, fortunately provides lessons which mainly fall into the first of these classes.

Reyrolle & Company, Ltd., was inaugurated in 1901 for the manufacture of ordinary designs of open type switchgear and accessories, including motor starters, knife switches, tubular fuses and wall plugs. At that time electrical apparatus of a substantial design and sound workmanship was easier to design than to obtain, and as the late Mr. Reyrolle had in his earlier works in London already established a reputation for these qualities in his output, it is not surprising that the business was soon thriving. Two or three years later the additions of further experts to the staff allowed attention to be given to the production of the special forms of switchgear and protective devices which were found to be necessary on the larger power supply systems and with the employment of higher electrical pressures then coming into use. Certain novel principles of design were introduced including the complete enclosure and immersion of all conductors, while new methods of locating and isolating faults were developed and successfully applied to the power station and sub-station equipment of the local power companies who were thus assisted in maintaining a continuity of supply.

For many years these local users absorbed the whole of the company's output of this special apparatus, and information thus obtained of working conditions allowed the designs to be modified as required to withstand the increased stresses which occurred as the generating plant grew. The first outside tender was at Stepney, and since that time the demand has consistently grown, so that it may be said the designs are now firmly established in British practice. Indeed, whatever may be thought of the general electrical engineering developments of foreign countries it will be agreed that at least the switchgear standards uphold the superiority of British practice.

During the war Messrs Reyrolle undertook the manufacture of shell fuses, though the Company's ordinary productions were in greater demand than ever for munition factories and extensions to power supply stations. It is interesting, however, to hear that much was learnt from the repetition production of shell fuses, which has been usefully applied in the processes of switchgear manufacture. The orders at present in hand include some of the largest contracts ever placed for switchgear for use in Great Britain. They comprise the main 20,000 volt controlling apparatus at the new capital station at Dalmarnock and similar apparatus for the Nechells of the Birmingham Corporation.

Messrs. Reyrolle's staff have always kept well abreast of the times with the result that, whenever some new demand or important change takes place in the use of electricity, the Company are always to the fore with productions which embody their well-established principles. But the restricted size of the works and the difficulties of manufacture have, to a great extent, limited the scope of the supplies to the home market, though care has also been taken to keep in touch with the fringe of the Colonial and foreign markets. As an example of the influence of British practice in the Continent, we may mention Holland, whose engineers for the Government interlinking scheme have visited this country and have ordered armourclad switchgear.

View of Reyrolle's New Shops.

The Company is lucky in being established on the North-East Coast, where generating plant installed for electricity supply already amounts to over 300,000 kw. over an area of more than 1,000 square miles. It has taken full advantage of its opportunities, but it is nevertheless handicapped by want of material, room and plant. As to material improvements have been made in the organisation to ensure supplies as and when required by the shops, but with more adequate facilities for production, a more fruitful effort to supply the increasing demands will become possible. We are not therefore surprised to learn that fresh capital is required, but we shall be surprised if it is not forthcoming.

Association of Consulting Engineers—Annual Dinner.

The annual dinner of the Association of Consulting Engineers held last Friday was a thoroughly pleasant function, and an agreeable contrast to those unwieldy banquets where ceremony is pronounced and where the speeches are delivered to the accompaniment of a subdued buzz of conversation. The chair was taken by Mr. H. J. Rofe, Chairman of the Committee of the Association, and among the guests were Viscount Cowdray, P.C., Mr. L. B. Atkinson, Capt. H. R. Sankey, Mr. Roger T. Smith, Sir John Snell and Sir F. J. Willis.

Mr. W. B. Clode, K.C., proposed the toast of "The Association of Consulting Engineers," in a humorous speech. The Chairman, in responding, said it had originally been held in certain quarters that the Association was being run by a small clique of engineers for their own benefit. This was far from the case, the effect of the Association's activities had certainly been the raising of the status of the profession and the maintenance of a high standard by the younger members as well as by those who had been long established. The Association was now well recognised by other bodies.

The toast of the "Engineering Institutions" was proposed by the Chairman. Capt. Riall Sankey, in reply, desired to enlarge the toast so as to include more than the three main institutions, as they all tended to work together. He also referred to the Registration Bill of the Institution of Civil Engineers as a very important attempt to enable engineers to do their duty to the public. Mr. Roger T. Smith also responded to this toast, but he was by no means so ready as Capt. Sankey to accept the proposed Registration Bill. He pointed out that the Institution of Electrical Engineers had long since ceased to be a purely professional body—it now represented an industry. A large proportion of the members were now engaged in manufacturing and in this branch of work the highest attainments were necessary. It would be difficult for the Institution to adopt the principle of registration unless the scheme could include, say, the wireless engineer, the electro-metallurgical engineer and all those engaged in the numerous branches of manufacturing. It seemed to him it would be difficult to devise a classification that would be adequate.

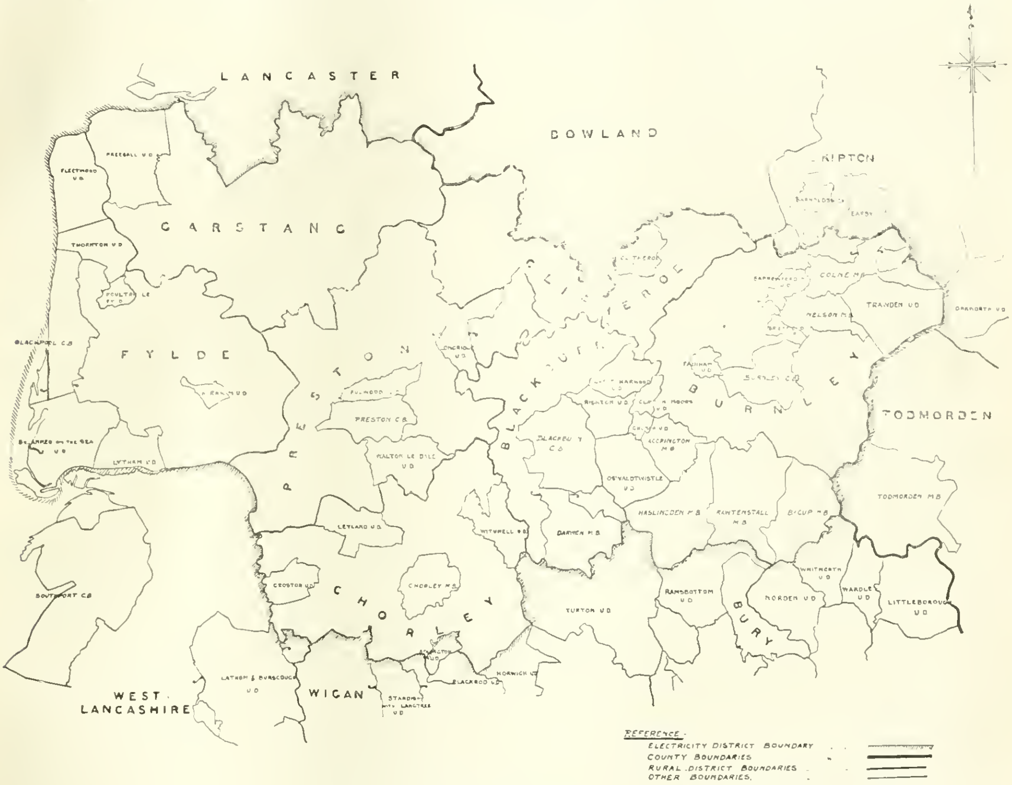
Mr. Midgley Taylor, in proposing the "Future of British Industries," referred to the importance of electric power, water power and oil in this country. As to the future, this would depend much on the British working man. The present restriction of output was calamitous, and he wished it were possible to impress upon the minds of working men the need for giving an honest day's work for a good day's pay.

Lord Cowdray (President of the Federation of Civil Engineering Contractors), in responding, said he had no fear for the future. The present position had been caused largely by lack of knowledge on the part of the Government. It was impossible to deal satisfactorily with labour in sections as had been done. As to oil, the output in the United States had increased in a few years from four millions to 50 million tons per annum, and half the deposits had been exhausted thereby. Experts held the view that only another 20 years supply was left. It was, therefore, useless to build extravagent hopes on oil. In his opinion, to use oil for steam raising was simply criminal folly.

Mr. L. B. Atkinson, who also responded to this toast, remarked that although there was a great manufacturing boom at present we might well pause to consider what might be ahead. Manufacturers were confronted daily with advances in wages and materials. Leaders of Labour were no doubt well aware that increased production was the difficulty, but at the back of all the trouble was the fear of unemployment. The view was gaining ground that the normal labour equipment would have to be carried by each industry in bad times as well as in good. This would render necessary co-operation between firms so as to distribute the work with some evenness during bad times, and it would be largely helped by standardisation.

Mid-Lancashire Electricity District.

It has been officially notified that the Electricity Commissioners have provisionally determined that the undermentioned area shall be constituted a separate electricity district for the purposes of the Electricity (Supply) Act, 1919, that is to say :—



Map of the Mid-Lancashire Electricity District.

The County Boroughs of Blackburn, Blackpool, Burnley and Preston ; the Boroughs of Accrington, Bacup, Chorley, Clitheroe, Colne, Darwen, Haslingden, Nelson and Rawtenstall ; the Urban Districts of Barrowford, Brierfield, Church, Clayton-le-Moors, Croston, Fleetwood, Fulwood, Great Harwood, Kirkham, Leyland, Longridge, Lytham, Oswaldtwistle, Padiham, Poulton-le-Fylde, Preesall, Rishton, St. Annes-on-the-Sea, Thornton, Trawden, Walton-le-Dale, and Withnell ; and the Rural Districts of Blackburn, Burnley, Chorley, Clitheroe, The Fylde, Garstang and Preston. The area of the new electricity district is shown on the accompanying map.

Objections or representations may be made on account of the inclusion of any area in, or the exclusion of any area from. the district, and all such objections or representations must be made in writing to the Secretary of the Electricity Commission by Sept. 30, 1920.

The Commissioners consider the existing organisation for the supply of electricity in the district should be improved, and therefore they intend to hold a local inquiry into the matter, and any authorised undertakers' or any railway company using or proposing to use electricity for traction purposes or any association or body directly concerned with the production or use of electrical energy within the district may, on or before Sept. 30 next, submit in writing a scheme for effecting such improvement in organisation, including the formation of a Joint Electricity Authority for the district, and any proposals for altering or adjusting the boundaries of the district so provisionally determined.

Proper Assessment of Illumination.

Not many years ago the sole criterion in judging artificial lighting was the candle-power of the lamp ; everybody thought in terms of candle-power. If lamps of a certain size failed to provide sufficient light for the purpose in view, the usual remedy was to install larger lamps. A man might say that a 20-c.p. or 50-c.p. or 90-c.p. lamp would be necessary to light a particular room, without having the slightest idea of the degree of illumination actually required or produced. In other words, he tried to judge the sufficiency or insufficiency of the light by looking at the candle-power or watts rating of the lamps, and often on the still more precarious basis of apparent brightness. Nowadays this rule-of-thumb attitude is giving place to a more scientific conception of the function of artificial lighting. It is fairly generally understood that candle-power is merely the basis of calculation—the raw material of illumination. The thing that matters is effective illumination on the plane or throughout the cubic area which it is desired to light. The aim of the modern illuminating engineer is to produce useful and definite results in the shape of foot-candles of illumination for the lowest possible total candle-power.

In many factories, especially those operating on the multi-shift system, it is important that the intensity of the artificial lighting should approximate to average daylight values, in order that the efficiency of the workers shall not be adversely affected during night work. Nothing could be easier than to measure with a foot-candle meter the intensity of daylight illumination on machines and benches, and then later on, to test the artificial illumination in the same manner. Daylight varies within wide limits, but every factory manager has a pretty good idea of what constitutes sufficient daylight for efficient working. He would probably take his daylight measurements on the sort of day that is commonly called dull, when the light, although not of very high intensity, is well-diffused, and comfortably adequate. The test values obtained on such a day, in a factory with plenty of window space, could be taken as a fair standard. Supposing the factory manager were to find that the average daylight values necessary for good vision were in the neighbourhood of 8 or 10 foot-candles, and that the average intensity of his artificial lighting was about 2 foot-candles, he would need no other explanation of the slackening in production in the winter afternoons and during the night shift. And if he is a wise man he will send for an illuminating engineer and ask him to correct the discrepancy.

The Skerne Works, Darlington, provides an example of artificial lighting designed to produce illumination results roughly equivalent to diffused daylight. Mazda half-watt type lamps in mazdalux metal reflectors are fixed close to the ceiling and are spaced to ensure an even distrbution of light. The illumination on the working plane is of a higher intensity than is commonly employed, but it is not a bit too high for the maintenance of maximum speed and accuracy of production. The effect is roughly what one would expect to find by day in a factory with a saw-tooth roof. In this particular interior the walls and ceilings are comparatively dark, and semi-indirect lighting was, therefore, not considered suitable. The distribution and diffusion of the illumination are remarkably good, and, owing to the high suspension of the units and the depth of the mazdalux reflectors, there is no perceptible glare. In designing the installation the fundamental consideration was the intensity in foot-candles on the working plane. That the pre-arranged value was obtained for a relatively low energy expenditure is a tribute to the high efficiency of the light units and to the skill of the British Thomson-Houston Company's illuminating engineers.

New Cable-Laying Steamer.

A new cable-laying and repairing steamer, the "Lady Denison-Pender" was launched at Govan on Saturday from the yards of the Fairfield Shipbuilding & Engineering Co. The new vessel is a twin-screw steamer, and is 282 ft. 8 in. in length, 38 ft. in breadth, 25 ft. in depth to shelter deck, of 2,000 tons gross, and 1,900 tons carrying capacity on a draught of 17 ft. 6 in., and with a speed of 12 knots. She is rigged as a two-masted schooner, with two 5-ton derricks on the foremast, and she will be fitted with the Marconi system of wireless telegraphy. There are three cable tanks, having a total capacity of 20,830 cubic feet, or 600 nautical miles of cable. There are also two sets of cable-working machinery, with bow sheaves of an improved pattern. There is accommodation for a complement of 100, with hospital, surgery, cable-testing room, refrigerating chamber, large chart-room, and the usual workshops and store-rooms. The propelling machinery consists of two sets of three-crank, triple-expansion engines, having cylinders 15½ in., 25 in., and 41 in. in diameter respectively, and a stroke of 30 in. Steam is supplied by three single-ended, cylindrical boilers fitted with Howden's system of forced draught. In addition, there are arrangements for burning oil fuel on the Wallsend-Howden system, and there is also a complete installation of independently driven auxiliary machinery.

There were present at the launch Sir John and Lady Denison-Pender, Rear-Admiral Grant, joint managing director of the Eastern Company and Mrs. Grant; Mr. F. A. Johnston, director, and Mr. F. C. Moss, Glasgow representative of the company; Mr. W. H. Tweedy, Mr. J. L. Geddes, Capt. Wightman, Mr. W. H. Skinner, &c.

Sir **Alexander Gracie**, K.B.E., M.V.O., Chairman of the Fairfield Company, presided at the subsequent luncheon and proposed "Success to the New Ship and the Health of Lady Denison-Pender." It might not be generally realised that the Eastern Telegraph Company had done great work for the Empire during the war. Very few, if any, companies had done so much, and in concluding he presented Lady Denison-Pender with a silver bowl as a souvenir of the launch.

Lady **Denison-Pender** having replied personally, Sir **John Denison-Pender** also acknowledged the toast. He said the new vessel was of a special class, and she would take her place in a fleet of 17 steamers which took turns of duty in all parts of the world. These vessels were always ready to leave harbour at any time when cables required attention. Before the war the company had sufficient cable capacity to allow for breakages, but after the war began two of the European cable companies dropped out and the traffic on the Eastern Company's lines increased in consequence by about 300 per cent. That entailed very great delays, and traffic began to pile up. During the past twelve months, however, they had been able to lay another direct line practically between this country and Bombay, and that was finished the week before last. At one time the delay in cabling to the East extended to five or six days. Now it was only about 24 hours, while they worked off arrears every week-end and were clear on Monday morning.

Commercial Topics.

Health Insurance Changes.

The National Health Insurance Act, 1920 which has received the Royal assent, makes important changes in the benefits and contributions under the Health Insurance scheme to operate from July 5 next. The normal rate of sickness benefit will be raised from 10s. to 15s. a week in the case of men and from 7s. 6d. to 12s. in the case of women. Disablement benefit will be raised from 5s. to 7s. 6d. for men and women, and the maternity benefit from 30s. to 40s.

In order to provide for the increase of benefits, the joint weekly contribution is to be increased from 7d. to 10d. in the case of men and from 6d. to 9d. in the case of women, of which the employer's portion will normally be 5d. in each case. The contribution cards from the week beginning July 5 must therefore be stamped at the rate of 10d. a week for men and 9d. for women.

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Electrical Development in India.

We have recently referred to the signs of industrial progress in India and to the desirability of British manufacturers and exporters keeping in touch with the demands of the local markets. There is great post-war activity in all branches of engineering, but particularly in that of electricity supply. Proof of this activity is given in the recent report of the directors of the Calcutta Electric Supply Corporation which refers to the desire of the Indian Government to encourage the development of the economic resources of the country. As the result of a report by their engineers, the company find themselves inevitably committed to a great increase of their system. The sum immediately involved is not less than 1½ millions sterling. The capacity of the power station must be more than doubled and the distribution network extended in like proportion.

The Madras Electric Supply Corporation also propose to make considerable extensions of their plant and mains. Four 250 kw. rotary converters and a water-tube boiler have been ordered, and will be shipped about the end of the year, when additional mains will be available. In view of the increasing demand for energy an additional 3,000 kw. turbo-alternator is necessary, and in order to provide the money a new capital issue is to be made.

Judging by the statement made at the meeting of the Oriental Telephone & Electric Company last week, the demand for telephone plant and apparatus is also very brisk. At both Bengal and Bombay, where good progress was made last year, there are long waiting lists of subscribers and complaint is made of the difficulty in getting supplies. As the Government is likely to exercise its right to purchase the undertakings in 1923 the normal rate of progress will probably be affected for some time to come unless the company can come to a working agreement with the Government.

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Exhibits of British Goods Abroad.

Some severe criticism of the exhibition of British-made goods which was held in Athens in October and November last is contained in the Commerce reports of the United States Consul-General (Mr. W. Weddell) at Athens. It is sometimes well to see ourselves as others see us, and, though some of the strictures passed on the exhibits are unmerited, there is a certain amount of truth in some of Mr. Weddell's statements. He admits that the greater portion of the exhibits were sold, and that orders had been placed for large quantities of goods for future delivery; but, considered in its larger aspects, the scheme and its working out must be considered a failure. In size alone the exposition fell below the average State fair in America, and in many lines there were indications that the potential market had not been closely or intelligently studied by the exhibitors. In many lines exhibits were not of a serious character, being little more than the samples which an active commercial traveller in the States would carry with him on his usual rounds; some even fell below this standard. The Near Eastern market was not properly studied by the British manufacturers before planning their exhibits. For example, not a single cigarette-making machine, not a machine for cleaning currants, or a wood-working machine was to be seen. Olive and wine pressing machinery was also lacking. Weaving, spinning and hosiery machines were not to be found. On the other hand, massive machinery, which could only be sold in a highly industrialised country, was prominently exhibited. An attempt was made to push wall papers, and this in a country where the article is practically unknown. English woollen fabrics were inadequately represented by only about half a dozen firms.

An equally serious drawback to the success of the undertaking was the fact that many of the firms declared themselves ready to take orders for future delivery only, in some cases after many months. The exhibition was disproportionately small, if intended to be truly representative of British manufacturers. It was opened too soon and before the exhibits were ready, so that for a long period interested visitors were able to see in many stalls only unopened packing cases containing articles which they were desirous of examining.

The report bears evidence of first-hand knowledge of the Near East markets on the part of Mr. Weddell, and though the criticism and analysis of the exhibits may be unduly severe, we think that the matter should receive careful attention by British manufacturers and exporters. The Athens exhibits may have been lacking in some respects, due mainly to transport and other difficulties; but it would be well to make a closer and better study of local requirements before embarking on any similar venture in future.

Electricity Supply.

The Stoke Newington (London) Borough Council has been authorised to borrow £300 for extension of mains services.

The new streets in Torry are to be illuminated electrically by the Aberdeen Watching and Lighting Committee.

Wimbledon Corporation has applied to the Electricity Commissioners for sanction to a loan of £40,000 for additional generating plant.

It is proposed to install an additional 1,000 kw. or 1,500 kw. turbo-alternator at Exeter, and the sanction of the Electricity Commissioners is being sought.

Wrexham Corporation has applied for authority to expend £17,000 on a new boiler, stoker, coal bunkers, economisers and a water softener at the Electricity Works.

Of the profit of £2,377 on the past year's working of the Bury (Lancs) Corporation electricity undertaking £1,000 is being used for relief of rates, and the remainder is being placed to reserve.

The town of Lanark, which is fast becoming a manufacturing and industrial centre, is anxious to have the advantages of electricity supply, and an electrical engineer is to report on the question.

The Lurgan Urban Council electric supply scheme, which was held up owing to the war, will probably be carried out as soon as Mr. Pleasance, consulting engineer, has prepared revised estimates of the cost.

Tyrone County Council has authorised the Fintona Electric Lighting Company to erect poles and overhead wires for lighting and power supply. There are some local mills which will probably adopt the electric drive.

The Newcastle-on-Tyne Corporation are to be asked to instruct the Parliamentary Committee to consider the question of the exercise by the Corporation of their rights of purchasing the electric lighting undertakings in the city.

Bradford Electricity Committee recommends the Corporation to obtain estimates of the cost of a new boiler house and for four boilers, stokers, coal-handling plant, &c., at the Valley-road electricity works, which are calculated to entail an expenditure of £322,700.

Extensions of the Darlington electricity works have been decided upon by the Electricity Committee. It is proposed to install four new boilers and two 5,000 kw. generating sets. Two boilers and one generating set will be ordered immediately so as to provide for the prospective demands of next winter.

Burnley Corporation has applied for sanction to a loan of £120,000 for extensions of plant, and £20,000 for mains. The lowest tender for the required plant amounts to £120,000, and 16 months will be required for the completion of the work. As the tenderers stipulate for an increase in the amount in the event of a rise in the price of materials and wages, the estimate of £120,000 may be exceeded.

Electric Traction.

The strike of Swansea tramway and omnibus employees, which lasted 33 days, has ended, and the men returned to work on Saturday last on the terms offered.

Yorkshire County Council has authorised the Keighley Corporation to extend the trackless trolley car service from the present terminus at Ingrow Cross Roads to Oxenhope, a distance of 3¾ miles.

By arrangement with the Middlesex and Surrey County Councils, the London United Tramways has been allowed to increase the existing fares by 50 per cent., except in the case of workmen's fares, which are to remain unchanged.

The Home Office has sanctioned the use of small electric locomotives in coal mines. These locomotives which have hitherto been employed in iron mines as feeders from the faces to the main roads, are designed to haul a load of 10 to 15 tons on the level, or about 3 tons up a gradient of 1 in 30. The overall length is 6 ft., with a wheel base of 2 ft. 4 in., but they may be made to suit any gauge of track from 19 in. upwards. Each locomotive carries a battery of 24 cells of the iron-clad Exide type, with a capacity of 193 ampere-hours. These are charged from a station in the mine, the current being derived through a converter. A normal charge is equivalent to a mileage of 20 to 25 miles, and the locomotive has a rated speed of six miles per hour when light, and five miles on load.

Tenders have been invited from the leading electrical engineering firms for the equipment of the Post Office Tube Railway, on which automatically-operated trains are to be run. The system to be employed has been evolved after investigation by the engineers of the Post Office. Many trial runs have been made on an experimental track at Woolwich, in which the gauge, gradients and radii of curves of the actual line were reproduced, and it has been shown that the method is capable of achieving all that is required. It is, however, announced that if any firm has an alternative method or any improvement to suggest, it will receive consideration. The first section of the "Tube" extends from the western terminus at the Paddington District Office to the Eastern District Office at Whitechapel, a distance of about 6½ miles; the line will not only link up these two offices, but also the Western District and Western Central District post offices, the Western Parcels Office, the mail sorting office at Mount Pleasant, the new General Post Office, the North-Western Railway through the Broad-street terminus, and the Great Eastern Railway. To avoid other tube lines, the depth of the railway from the surface varies between 28 ft. and about 90 ft. The original estimate of cost was about £950,000, but this figure has been greatly exceeded owing to the cost of labour and materials. Considerable extensions are contemplated should the working of the railway prove satisfactory.

Telegraph and Telephone Notes.

The U.S.A. House of Representatives has passed a resolution authorising the Navy Department to continue for a period of not more than two years the operation of all wireless stations for the use of the public. The resolution will be considered by a conference of the Senate and the House. The charges are to be fixed by the Secretary for the Navy.

It has been decided to recruit at once 150 wireless operators and a number of wireless electricians, fitters and instrument makers for the Army Signal Service. Applicants must be between 18 and 25 years of age if enlisting on normal engagements, and ex-soldiers enlisting for two, three, or four years with the Colours, and men who have not previously served in the Army, enlisting for similar periods, must be between 18 and 38 years of age. A bounty of £100 will be paid after passing the trade test as wireless operators, and of £50 to those passing the test as electricians, &c.

Last week Reuter announced that the Pacific Cable Board was considering the laying of a duplicate cable from Vancouver to Norfolk Island, a distance of 6,500 miles. The cable could not be completed until 1921, and would cost nearly £4,000,000. The existing Pacific cable, which was completed in December, 1902, was laid by the Telegraph Construction & Maintenance Company for the sum of £1,795,000.

We are informed that the announcement is unauthorised, and conveys a wrong impression. The Pacific Cable Board desire to state that, while the question of improving cable communications in the Pacific is naturally receiving their attention, no decision has yet been taken, and the matter has not yet been considered by the Governments which are partners in the Pacific Cable (the United Kingdom, Canada, Australia, and New Zealand).

The Imperial Wireless Telegraphy Committee, which was appointed in November last (with Sir H. Norman as chairman) to prepare a complete scheme of Imperial wireless communication, has presented a unanimous Report. According to "The Times" the Report is long and covers the whole field of long-distance wireless telegraphy. The Committee has considered what high-power wireless stations it is desirable, on commercial or strategic grounds, that the Empire should ultimately possess. It has prepared estimates of the capital and annual costs of each station and the life of the plant and buildings, the probable amount of traffic and revenue which may be expected from each station. The stations recommended are placed in their order of urgency. It is expected that as the question is one of national and Imperial interest the Report will be published without delay.

Our enterprising contemporary, the "Daily Mail," has created a record in the history of journalism by the inauguration of a wireless telephone service. On Friday afternoon two messages, sent by a reporter from the Marconi station at Chelmsford, were picked up by the receiving set recently installed in the London office of the journal, the transmission being made on a wave-length of 2,800 metres. The Postmaster-General's authorisation limited the experiment to 20 minutes. The first message related to experiments carried out at Chelmsford in wireless telephony between an aeroplane in flight and the ground station, and the second to a police court case heard at Chelmsford. The messages were taken down in shorthand by other reporters, and a song lasting two minutes concluded the test. "Listeners in" in various parts of the country, including a member of The Electrician staff at Watford, and others at Birmingham, Canterbury, Cleethorpes and Sale (Cheshire), heard the messages distinctly.

Imperial and Foreign Notes.

An offer by Launceston (Tasmania) Council to supply electrical energy to the township of St. Leonards, about five miles away, is being considered by the St. Leonards Council.

Among the various projected Colonial electric supply schemes are the following:—In Jamaica it is proposed to spend about £200,000 on hydro-electric works. Electric lighting is being introduced in the Seychelles, and tenders for the lighting of Port Victoria in Mahé, are being invited. The programme of the Development Board of the Government of the Bahamas includes the development of electricity works, cold storage plants, &c.

Owing to their utility in strikes, Oil-Electric Locomotives, which have been used with success on the Nord railway system, are to be brought into more general use in France. The number of lorries needed for provisioning Paris would be over 4,000, but 50 oil-electric locomotives, which can be driven by one man each, would ensure the provisioning of the city. Thus some 50 or 60 volunteers able to drive these engines would be sufficient, and a school has been organised at Saint Eulien, near Saint Dizier, where the Saint-Chamond Company already has 120 such locomotives.

It is reported that the question of developing the international section of the River Douro, where 450,000 h.p. can be obtained, is the subject of negotiations between the Governments of Portugal and Spain. A commission from the Portuguese Ministry of Public Works is in Madrid for the purpose of discussing with delegates of the Spanish Government the division of the power from the projected hydro-electric works. If the negotiations succeed it is anticipated that a great part of the available power will be employed on the Spanish side, in the electrification of certain sections of railway line in the Asturias region. For about 75 miles the river forms the frontier between Spain and Portugal, and along this stretch the waters descend 1,250 ft.

Institution Notes.

The annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, Cromwell-road, South Kensington, by permission of the trustees of the Museum, on Thursday, July 1, from 8 p.m. to 11 p.m.

At the Wireless Sectional Meeting of the Institution of Electrical Engineers to be held on Wednesday, June 23, at 6 p.m., at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., a Paper will be read by Mr. B. S. Gossling, entitled " The Development of Thermionic Valves for Naval Uses."

Engineers or others who are interested in the Papers to be read at the forthcoming Incorporated Municipal Electrical Association Convention, to be held at Bradford, and who wish to be present to speak thereon, should communicate with the Secretary, I.M.E.A., Electricity Works, Factory-lane, Croydon.

At the Academy of Sciences, Paris, last week, M. Berthelot announced that an important discovery had been made by Dr. Pech, which would ensure the protection of operators against the effects of X-rays. It consists of a process which neutralises the ultra-violet rays by the simultaneous application of infra-red rays.

Vacancies on the Committee of the Association of Consulting Engineers have been filled by the election of the following members: H. R. J. Burstall, W. Vaux Graham, K. P. Hawksley, J. H. Rider and A. M. Sillar as London representatives, and James Caldwell and F. W. Hodson as country representatives.

The following have been nominated Ordinary Members of the Wireless Section of the Institution of Electrical Engineers: Messrs. R. C. Clinker, C. L. Fortescue, M.A., O.B.E., L. B. Turner, M.A. and Capt. H. J. Round, M.C. Members of the Institution who wish to become members of the Wireless Section should communicate with the Secretary. The qualifications are they must be " actively engaged in the study, design, manufacture, or operation of wireless of high frequency engineering apparatus."

Miscellaneous.

The Little Wonder Battery Company, Ltd., is being wound up voluntarily, and Mr. R. G. Pye, 26, Budge-row, London, E.C.4, has been appointed liquidator. A meeting of creditors will be held at 26, Budge-row, on June 8.

Two men were accidentally killed by electric shock at Newcastle-on-Tyne on Sunday when repairing a fuse box. The two killed and another were engaged in connecting up the wires, when, for some unexplained reason the current was turned on.

The death is announced of Lieut.-Col. A. Stowell Jones, V C., M.I.C.E., in his 89th year. After retiring from the military service he took up sanitation work at Wrexham, and he became an authority on sewage disposal. For some 15 years before his retirement at the age of 80, he was engaged in sanitation at Aldershot.

In the report to the Home Office by H.M. Inspectors of Constabulary it is stated that the police in many places have expressed a decided Preference for Electric lamps to replace the oil pattern generally in use. Though many experimnets have been made the " perfect police lamp " has still to be found, and it is stated that the trade itself could assist in this direction. A good pattern of dry cell lamp would be welcomed where the wet accumulator pattern is impracticable on account of difficulties of replenishment, or unpopular on account of weight.

The termination of a popular series of social evenings held by Pope's Social Club throughout the winter was marked by an eminently successful whist drive and fancy dress ball on May 19, at which Mr. Stanley Carman, Works Manager, Pope's Electric Lamp Company, was present. There were many striking costumes to be seen among those worn by the 600 members and friends who attended, one of the prize winners being Miss Nunny, who represented an up-to-date " Pope " electric lamp. At the close of the proceedings Mr. A. E. Marx (sales manager) distributed the prizes.

Educational.

The appeal for funds for the Liverpool University is meeting with a generous response, the latest donors being Mr. T. Harrison Hughes, who has subscribed £50,000 and Messrs. A. Holt & Co. who have given £5,000.

The total of the University College Engineering Fund is now £32,375. Recent contributions include two sums of £500 each from America, £250 from the Gas Light & Coke Company, £50 from the Igranic Electric Company, and 5,000 frs. from M. C. P. Eugene Schneider. A promise of apparatus to the value of £50 has been received from Messrs. Nalder Bros. & Thompson. Contributions may be sent to Prince Arthur of Connaught at 42, Upper Grosvenor-street, W. 1, or to the Hon. Treasurer, Sir Ernest Moir, at University College, London.

At a mass meeting of technical teachers in the London area last week, a resolution was passed urging the adoption of the following minimum scale of salaries, with a substantial increase in the case of teachers in the London area: Assistants, £300 to £600, and principal assistants, £400 to £700 in ten years. Heads of departments (three grades according to work and responsibility: (*a*) £500 to £700 in five years; (*b*) £600 to £800 in five years; (*c*) £800 to £1,000 in four years.

It was resolved to press for an immediate reconsideration of salaries and a temporary bonus or increase, to be afterwards incorporated in any scale which may be agreed upon by the Burnham Committee.

Tenders Invited and Accepted.

Grimsby Corporation require tenders by June 7 for e.h.t. feeder cables and pilot cables. Specifications from the Borough Electrical Engineer.

Carlisle Corporation require tenders by June 25 for 3,000 kw. turbo-alternator and condensing plant. Specifications, from City Electrical Engineer.

Edinburgh Corporation require tenders by June 19, for e.h.t. and l.t. switchgear, &c., for their Portobello station. Specifications from the Engineer.

Warrington Electricity and Tramways Committee require tenders by June 15 for motors and transformers. Specifications from Borough Electrical Engineer.

Bethnal Green (London) Council require tenders by noon, June 7, for two 500 k.v.a. transformers, e.h.t. and l.t. panels, l.t. feeder cables, &c. Specifications from the Town Clerk.

Dundalk Urban Council require tenders by 6 p.m. June 15 for l.t. three-cored paper-insulated lead-covered and armoured cable and joint boxes. Specifications from the Engineer and Manager.

London County Council require tenders by noon, June 15, for 4,000 driving and 3,500 trailing wheel tyres. Forms of tender from the Manager, L.C.C. Tramways, 23, Belvedere-road, S.E. 1.

Rhondda Education Committee require tenders by noon, June 15, for wiring their Porth, Tonypandy and Pentre secondary schools (about 489 points). Specifications from Mr. J. M. Bowman, Electricity Works, Porth, Glam.

Southampton Corporation require tenders by June 14 for e.h.t. switchgear for control of three-phase alternators, converter, transformers and feeders; h.t. transformers and d.c. panel. Specifications from Borough Electrical Engineer.

The Victorian Railway Commissioners require tenders by July 14 for track relays (contract 33,055) and twin-wire cable (contract 33,056), for power signalling. Specification from the Commissioners' Offices, Spencer-street, Melbourne.

Barnes Urban Council require tenders by noon, June 7, for coal handling plant and overhead steel or ferro-concrete bunkers. Specification from the Engineer and Manager, Electricity Works, High-street, Mortlake, London, S.W. 14.

Ince-in-Makerfield Urban Council require tenders by June 15, for (1) two electric motor-driven turbine vertical duplicate pumping sets; (2) two horizontal ditto; (3) cables; (4) conversion of winding engine to electric drive; (5) switchgear. Specifications from the Clerk.

Bedford Corporation electricity department invite tenders for the supply and erection of one 2-ton locomotive jib crane, grab and track rails, and steam and other pipework. Specifications from the borough electrical engineer, Mr. R. W. L. Phillips, to whom tenders by June 21.

Newport (Mon.) Corporation invite tenders for turbo-alternator and surface condensing plant, boiler, economisers, draught plant, steel flue and stack, &c. Specifications from the borough electrical engineer and tramways manager, Mr. A. Nichols Moore; and tenders to the Town Clerk, by June 26.

Leeds City Council invite tenders for a steam turbine, three-phase alternator and exciter of 1,200 kw. capacity or thereabouts. Specifications from the manager of the electricity department, Mr. C. Nelson Helford, 1, Whitehall-road, Leeds, and tenders to the Town Clerk, 26, Great George-street, Leeds, by 11 a.m. June 14

Doncaster Corporation has placed an order for two turbo-generator sets with Messrs. J. Howden & Company at £48,542.

Rotherham Corporation has placed an order for two " Orwell " electric vehicles with Messrs. Mossay & Company, at £1,340 each.

St. Pancras (London) Borough Council has placed an order for two motor converters with Messrs. Bruce Peebles & Company, at £6,350 each.

An order for the supply of a boiler for Wrexham electricity works has been given to Messrs. J. Thompson Water Tube Boilers, Ltd., at £5,611.

Southend Corporation has accepted the tender of the English Electric Company for the supply of 24 40 h.p. traction motors, at £6,720, and for electric brakes, at £1,800.

The contract for electric traction lamps for the L.C C. tramways department has been secured by Cryselco, Ltd., the Maxim Lamp Works and Siemens Brothers Dynamo Works.

For the supply of three-core and four-core l.t. paper-insulated cables Nuneaton Corporation received ten tenders, varying from £6,203 to £7,588 10s., and that of the Western Electric Company (at £6,289 16s.) has been accepted.

Dundee Corporation has accepted tenders of Ferguson, Pailin, Ltd., and the British Thomson-Houston Company for switchgear and transformers respectively. The contract for the reinforced concrete foundations of the electricity station extension has been let to the Yorkshire Hennebique Contracting Company at £23,042. 15s. 6d.

Maidstone Electricity Committee has accepted the tender of the Union Cable Company for the supply and laying of cables to Snodland and the Cherry Orchard Estate at £30,426 and that of the Pirelli-General Cable Works for cables for the supply to Tovil at £2,767. Orders have been given for two 625 k.v.a. static transformers to the Brush Electrical Engineering Company (each), £898 9s., at £1,797, and for one 500 kw. rotary converter to the General Electric Company at £3,423.

Personal and Appointments.

Bath Corporation has increased the salary of the city electrical engineer (Mr. F. Teague) from £700 to £850 per annum.

Mr. A. M. Pemberthy, of Ruthin, has been appointed to manager of the Galway Electric Light Co., in succession to Mr. R. Collins.

The Cardiff tramway employees have presented Mr. Arthur Ellis, their late manager, with a silver inkstand, and Mrs. Ellis with a silver clock.

Mr. R. H. Stockdale, late Government electrical engineer in Mauritius, has been appointed local manager of the Oriental Telephone & Electric Company.

In recognition of the services rendered to the Yorkshire & District Tramways Managers' Association, Mr. H. England, of Wakefield, has been presented with a silver rose bowl.

On Saturday the Walsall tramway and motorbus workers gave an official farewell to Mr. R. L. Horsfield (general manager) and Mrs. Horsfield, who are leaving for Cardiff, and a presentation of an oak bureau was made to them.

Glasgow Corporation has granted the following increases of salary to officials of the electricity department: Mr G. L. Black, assistant engineer, from £425 (bonus £170) to £800, rising to £1,000 by £50 annually; Mr. W. T. Calderwood, constructional engineer, £450 (bonus £180) to £700, rising to £750 by £25 annually; Mr. C. W. Marshall, chief technical assistant, £320 (bonus £154) to £600, rising to £750 by £25; Mr. G. Morgan, stations superintendent, £320 (bonus £154) to £600, rising to £750 by £25; Mr. J. R. Cowie, sub-stations superintendent, £351 (bonus £160) to £600, rising to £750 by £25 annually; Mr. D. Berry, mains superintendent, £285 (bonus £147) to £600, rising to £750 by £25 annually without bonus additions, but the salary of Mr. R. B. M'Call, secretary and treasurer, has been increased from £600 (bonus £155) to £750, with bonus additions, and the salary of Mr. S. B. Langlands, inspector of lighting, from £650 (bonus £155) to £750.

Business Items, &c.

The London offices of the Hackbridge Cable Company, Ltd., have been closed down and all communications should be addressed to the company at Hackbridge, Surrey.

The Metropolitan-Vickers Electrical Company, Ltd., have moved their London office from 2, Norfolk-street, to 4, Central-buildings, Westminster, S.W. 1.

The partnership between Sydney Birch, Percy H. Tomkins and Ernest King (trading as Ernest King & Co.), electricians, engineers and contractors, 97, Bridge-street, Walsall, has been dissolved. Debts by Mr. Birch and Mr. Tomkins.

The Twiss Engineering Electric Transmission, Ltd., have concluded arrangements whereby they acquire the transmission line contracting department of Messrs. J. B. Saunders & Company, Ltd., which will, therefore, become incorporated in the company's organisation, together with the services of Mr. S. G. Leech, M.I.E.E., as the director of contracts, with a staff of erecting engineers, linesmen, &c. The Twiss Engineering Electric Transmission, Ltd., are expanding their works at Mildmay Park and laying down new plant. The capital has been increased in order to deal with the increasing volume of business, and the directors have decided to simplify the name of the company, which will in future be, Twiss Electrical Transmission, Ltd., the head office remaining at 62-63, Queen-street, E.C. 4.

As from the 1st inst., Messrs. Siemens Brothers & Company, Ltd., have taken over the lamp and supplies department of Messrs. Siemens Brothers Dynamo Works, and at the same time provision is being made for a largely increased output in metal filament lamps, which will henceforth be sold under the trade name of "Xcel." This name will apply to all types of the company's metal filament lamps, including the standard vacuum, half-watt and automobile and battery lamps (vacuum and gas-filled), as well as the helical filament traction lamps for electric tramways and railways, workshops and factories. Messrs. Siemens Brothers & Company will conduct the business in lamps and supplies from the same addresses in London and the Provinces as hitherto, where attention will be given to inquiries regarding the whole of the material manufactured at the Company's Woolwich works, such as wires, cables, Stannos wires, telephone and telegraph apparatus, fluid and dry cells, flash-lamp and torch batteries, &c. The showrooms at 38/39, Upper Thames-street, London, E.C., have been redecorated and trade buyers are invited to call. The advice of the illuminating engineering department will be at the disposal of contractors in connection with lighting.

Catalogues, Price Lists, &c.

Messrs. Greenwood & Batley, Ltd., Leeds, have issued a catalogue giving particulars of their "Bipol" electric storage batteries for pocket and hand lamps, police lanterns, &c., and also of the "Bipol" charging boards.

A pamphlet just issued by the Cox-Cavendish Electrical Co., of Twyford Abbey Works, Acton-lane, Harlesden, N.W.10, contains a full illustrated description of the company's apparatus for the X-ray examination of materials. Specifications of the two sets usually supplied, together with prices and other details are included.

The revised (1920) edition of section X of the General Electric Company's catalogue, dealing with switchgear, has just been issued. It forms a comprehensive publication regarding all apparatus which can be considered as coming under the heading of high tension switchgear. It gives details of oil break switches, tension limiters, lightning arresters, choke coils, isolating links, relays, time limit fuses, &c.

Companies' Reports, &c.

The Rothesay Tramways Company, Ltd., has declared a dividend of 3 per cent. on the ordinary shares for the past year. A sum of £1.000 has been placed to reserve and £1,692 carried forward. Mr. W. L. Madgen has been appointed chairman and Mr. P. N. Gray a director of the company.

The profit of the Lancashire Dynamo & Motor Company, Ltd., for the year 1919, after providing for debenture and bank interest, war taxation and income tax, was £19,938. With £4,331 from 1918 the disposable balance is £24,269. The interim and final dividends on the preference shares absorbed £1,879, and the directors propose to pay a dividend of 10 per cent. per annum (tax free) on the ordinary (as in 1918), to place £447 to reserve and to carry forward £5,542. No settlement has yet been arrived at for excess profits duty for 1917 to 1919, but provision has been made to cover the estimated liability.

The revenue of the Oldham, Ashton & Hyde Electric Tramway, Ltd., for the year 1919 was £59,102, and the expenditure (including £1,176 for debenture interest) £42,572, leaving a net profit of £16,530, which, added to £4,957 brought forward, makes an available balance of £21,487. The directors propose to place £10,000 to reserve fund, to pay the year's dividend on the 5 per cent. cumulative preference shares (£2,500) and a final dividend on the ordinary shares at rate of 6 per cent. for the year (of which an interim dividend for six months at rate of 5 per cent. per annum has been paid), leaving to be carried forward £5,987. The local authorities in whose areas the company's lines are situated have given notice of intention to purchase the undertaking, and the arbitration to determine the price will take place shortly.

The net profit of the Peel-Conner Telephone Works, Ltd., for the year ended March 31 was £31,595. A sum of £10,000 has been placed to general reserve, and £5,000 to depreciation reserve. Adding £8,560 brought forward, the balance is £25,155. An interim dividend was paid in November upon preference shares, and the directors recommend payment of balance dividend on the preference shares, and a dividend of 2s. per share, together with a bonus of 1s. per share on the ordinary shares, leaving to be carried forward £8,155. The works have been fully employed during the year. The great amount of orders in hand, as well as the growing demand for telephone equipment throughout the world, necessitates a considerable extension of works. A site has been acquired near Coventry, factory buildings are in course of erection, and a quantity of plant has already been secured. The funds for the extensions are being provided by the General Electric Company.

The report of the Electric Construction Company, Ltd., for the year ended March 31 states that, after providing £6,304 for debenture interest and £10,000 for depreciation, the net profit is £66,169. Adding amount brought forward (less paid on account of excess profits duty) and deducting the interim dividends on the preference and ordinary shares, the balance is £73,641. The directors recommend final dividends at rate of 7 per cent. per annum on the preference shares and at rate of 9 per cent. per annum on the ordinary shares (making 7½ per cent. for the year), and a bonus of 2½ per cent. on the ordinary shares, and also the transfer of £10,662. 10s. to general reserve (which will then amount to £100,000), leaving to be carried forward £39,781. The extensions of the works were only completed in time to permit of their contributing in a small degree to the profits of the past year. The moulders' strike caused great disorganisation, which will continue to be felt during the new year. The enlarged premises, however, will permit of an increased turnover, and the volume of unexecuted orders exceeds that of any previous period.

For the year 1919 the profit of Richardsons, Westgarth & Company, Ltd., was £185,040. Adding balance from 1918 and deducting year's arrears of preference dividend, the balance is £187,857. Out of this has been paid interest on 4½ per cent. perpetual debenture stock for year, three years' arrears of preference dividend (to April 30, 1914), and the directors propose to make various allocations to depreciation, &c., the balance being £48,842. Company's liability for excess profits duty for past four years has not been finally adjusted, but it is estimated that out of retainable profits for 1919 a total payment of £105,000 can be made to the preference shareholders. Of this sum a distribution of £63,000 has been made, and it is now proposed to pay £42,000, so that the preference dividend will then have been paid to April 30, 1916.

Mr. D. B. Morison, presided over the meeting on Monday and devoted the greater part of his speech to the deleterious effects of high taxation and shorter hours on industry. During the past year only three months were unaffected by labour troubles either in their own works or in the shipyards to which they supplied machinery, but in spite of that the output comprised the machinery for no fewer than 38 ships, aggregating 80,000 H.P., besides numerous sets of steam turbines for the generation of electric power. A ntoable contract was a 25,000 kw. electric generating set for Manchester, of which they supplied the turbine and condensing plant, and the Metropolitan Vickers Company the generator. This set was the largest in operation in the United Kingdom, and although the technical requirements were very severe, they had been successfully met, and the plant continued to give highly satisfactory results.

Mr. Morison said that as provision for efficient production was imperative there was good reason why sufficient money should be left to them by the Inland Revenue to make good the destructive effects on their plant due to the highly abnormal conditions of working which prevailed throughout the war period. Efficient production was vital to manufacturing success, and, if that efficiency had to remain seriously impaired because of the ravages of taxation, then their manufacturing position would be prejudiced to an extent that would only be revealed, all too late, when they were brought face to face with competition they might be unable to withstand. They had a very full order book, but their rate of production was deplorably low. Before the war the standard week was 53 hours, and the average hours actually worked per man per week were approximately 53. Now, when the standard week was 47 hours, but after making allowance for overtime and sickness, the average was 44. Furthermore, the actual time now taken to complete a given amount of work was, on an average, nearly half as long again as before the war. The effect of such a decrease in productive capacity, combined with the corresponding increase in working expenses per unit of work, must obviously be serious. The desideratum at the moment was the restoration of at least the pre-war output per man per hour.

Forty Years Ago.

(THE ELECTRICIAN, JUNE 5, 1880.)

THE LONTIN-MERSANE LIGHT.—The office-bearers of the Chamber of Deputies have paid a visit to the works of the Lontin-Mersane electric light in order to judge of its applicability to the Palais Bourbon. They expressed great satisfaction with the brilliancy, steadiness and manageableness of the light. M. Margaine stating that the rapidity of electric improvements had hitherto prevented the Chamber from adopting the electric light, lest by the time one system was installed a superior system should have superseded it. There is, however, an impression that gas has influential supporters at the Palais Bourbon.

THERMO ELECTRICITY.—At a recent meeting of the United States National Academy of Science, Prof. Langley spoke of an improved thermo-electric apparatus due to a product of the American iron industry. Experiments with a great variety of substances (for measurement of radiant heat) had thus far shown that iron in extreme thinness (cut into strips about one-third of a millimetre wide and one 500th of a millimetre thick) was the best. The speaker exhibited specimens of iron rolled in the Pittsburg mills, which were so surprisingly thin that from 10,000 to 12,000 sheets laid on each other equalled only one inch in thickness. From these was produced an instrument which had almost the promptness of action toward radiant heat which the eye has towards light, and which had greater sensitiveness than any thermopile.

TELEGRAPHING EXTRAORDINARY.—The "South Australian Register" says: The superintendent of telegraphs (Mr. C. Todd, C.M.G.) has kindly supplied us with the following information: On Sunday morning, the telegraph lines being clear of business, Melbourne and Port Darwin were put in direct communication with each other, the distance between the two places being 2,500 miles. The signals were perfect at each end, the line working splendidly right through, and the replies were instantaneous. The cable was then cleared, and communications exchanged with Singapore, a further distance of 2,200 miles, or 4,700 miles from Melbourne. Replies were received from Singapore in a few seconds, a message being sent and a reply received in the space of one minute from the commencement of the message. The messages had, of course, to be repeated at Port Darwin; but this was done simultaneously, so that little or no time was lost. Port Darwin and Singapore were in direct communication through the duplicate cable recently laid, which avoids the necessity of using the land line through Java. Since the duplicate cable has been submerged, the time occupied in the transmission of messages between London and Adelaide is greatly reduced, seldom occupying more than a few hours, and from Adelaide they invariably beat the sun, arriving at their destination in advance of the local time they were handed in.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics": Our Dinner to the Survivors of the First 100 British Aviators and the Pioneers of Flight (full list); "Some Points in the Work of the Advisory Committee for Aeronautics," by Capt. R. T. Glazebrook.

"Cabinet Maker": "First Exhibition of the British Institute of Industrial Art"; "British Antique Dealers' Association at Hatfield"; and "Cane Furniture for a Loggia."

"Chemical Age": "Work of the U.S. Bureau of Standards"; and "New President of Society of Chemical Industry."

"Fruit-Grower": "Decontrol according to Mr. McCurdy"; "Trade Exhibits at Chelsea Show"; "The Technique of Potato Breeding."

"Gas World": Special Number with report of Annual Meeting of the Institution of Gas Engineers; "Methods of Producing and Utilising Coal Gas"; and monthly Coking Section, with informative answers to the questions set in City Guilds of London Institute examination in Coke and By-Product Manufacture.

"Hardware Trade Journal": "British Blast Furnace Practice"; "Spurs in the Hardware Trade"; and "Labour Saving in the Foundry" (X.), by Joseph Horner.

"Ways and Means": "Making £5,000 a Year," by the Editor; "The Threatened War Levy," by John Burns, W.S.; and "A Career for Women," by Miss Evelyn Miller.

The Editorial, Advertisement and Publishing Offices of "THE ELECTRICIAN" *are at* 8, *Bouverie Street, London, E.C.*4. *Telegrams: Benbrotric, Fleet, London. Telephone: City* 9853 (4 *lines*).

The subscription to "THE ELECTRICIAN" *is* £2. 12. 0. *per annum in the United Kingdom, and* £2. 14. 0. *per annum Abroad. Advertisement Rates can be obtained on application to the Manager. Advertisement copy and blocks should be received on the Friday preceding date of publication.*

Arrangements for the Week.

FRIDAY, June 4th (to-day).

ROYAL SOCIETY OF ARTS.—INDIAN AND COLONIAL SECTIONS.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "The Oil Resources of the British Empire," by Prof. Sir John Cadman, K.C.M.G.

SATURDAY, June 5th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, London, W. Lecture on "The Theory of Quanta," by Dr. J. H. Jeans, F.R.S. (Lecture II.).

MONDAY, June 7th.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Aluminium and its Alloys," by Dr. W. Rosenhain, F.R.S. (Lecture III.)

WEDNESDAY, June 9th.

INSTITUTION OF ELECTRICAL ENGINEERS.—WIRELESS SECTION.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "High-frequency Machines," by M. Marius Latour.

THURSDAY, June 10th.

INSTITUTION OF MINING ENGINEERS.

11 a.m. At the Geological Society, Burlington House, London, W.1. Papers to be read: "Compensation for Subsidences," by Prof. H. Louis; "The Fleissner Singing-flame Lamp," by Mr. W. Maurice; "The Wolf-Pokorny and Wiede Acetylene Safety Lamp," by Mr. W. Maurice; "The 'Oldham' Cap Type Miner's Electric Safety Lamp," by Mr. G. Oldham. Discussion on First Report of the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines"; "A New Method of Working Thick Seams of Coal at Baggeridge Colliery," by Mr. D. S. Newey; "Protractors," by Mr. T. G. Bocking; and "Magnetic Meridian Observations: A Method of Utilising the Kew Observatory Records," by Mr. T. G. Bocking.

INSTITUTE OF METALS.

8 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Annual May Lecture on "The Recent Progress in Thermo-Electricity," by Prof. C. A. F. Benedicks.

FRIDAY, June 11th.

PHYSICAL SOCIETY OF LONDON.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers on "Radiation and Convection from Heated Surfaces," by Dr. T. Barratt and Mr. A. J. Scott, B.Sc.; "An Electrical Hot-wire Inclinometer," by Mr. J. S. G. Thomas, M.Sc.; "Convective Cooling and the Theory of Dimension," by Mr. L. F. Richardson; and "The Radiation from a Perfectly Differing Circular Disc."

Prices of Metals, Chemicals, &c.

TUESDAY, June 1.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£106 0 0	—	£1 0 0
Electro Wirebars...	,,	£107 0 0	—	£2 0 0
H.C. wire basis......	per lb.	1s. 2$\frac{15}{16}$d.	—	$\frac{3}{16}$d.
Sheet	,,	1s. 5¼d.	—	½d.
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7$\frac{15}{16}$d.	—	$\frac{3}{16}$d.
Brass 60/40—				
Rod, basis	,,	0s. 11d.	—	—
Sheet, basis	,,	1s. 3½d.	—	¼d.
Wire, basis	,,	1s. 3½d.	—	¼d.
Iron—				
Cleveland Warrants	per ton	£11 17 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£51 0 0	—	—
Lead Pig—				
English	,,	£41 10 0	—	—
Foreign or colonial	,,	39 0 0	—	£1 10 0
Tin—Ingot	,,	275 0 0	£5 0 0	—
Wire, basis	per lb.	0 3 7	1d.	—

Salammoniac.—Per cwt. 105s.-100s.
Sulphur (Flowers).—Per ton £19.
,, (Roll Brimstone).—Per ton £19.
Sulphuric Acid (Pyrites, 168°).—Per ton, £8 8s. 9d.

Copper Sulphate.—Per ton £46
Boric Acid (Crystals)—Per ton £74.
Carbon Bisulphide.—Per ton £60
Sodium Bichromate.—Per lb. 1s. 11d.
Sodium Chlorate.—Per lb. 5½d.

Rubber.—Para fine, 2s. 1¼d.: plantation 1st. latex. 2s. 1d. per lb.
Shellac.—T.N. Orange, 590s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Company, Ltd.

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED 1861.

No. 2,195. [No. 24. Vol. LXXXIV.] FRIDAY, JUNE 11, 1920. PRICE ONE SHILLING. *By Post, 1s. 1d. Abroad 1s. 2d.*

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Notes.

The "London Charlottenburg" Again.

IT is doubtful whether anyone holding a certain view upon a particular question was ever caused to change that view by mere argument. A further examination of evidence, an alteration in outlook or a desire to be among the majority, might, singly or in combination, bring about such a change, but argument by itself is often a weapon more useful to those against whom it is turned than to those who employ it. Certain it is that the contentions brought forward at the meeting on Friday last in support of a request by the Imperial College of Science for power to confer degrees and for University status, has not caused us to change our opinion on this particular question; neither has Sir ALFRED KEOGH's letter in "The Times," of Tuesday. Indeed, they both rather make us hold more closely to the view which we have always held. We admit that in some matters the present University of London is retrograde and that it is perhaps more unsympathetic than it need be towards the claims of the professorial staff and students of the Imperial College to have more say in the arrangement of the courses and the conduct of the examinations leading up to the degree, but we still remain unconvinced that all these matters could not be amicably arranged, and that in pressing for separation the Imperial College will not only be inflicting a stunning blow on the University organisation in London, but cutting off its hand to spite somebody else's face.

Modernisation Through Combination.

WE look forward to a great development of University teaching and influence in London, both on the technical and on the academical sides, to the shedding of old shibboleths, to the inculcation of modern ideas into both the organisation and into the curriculum of the University, into the springing up of a freer and fuller life; but all these most necessary and desirable tendencies will be strangled at their birth if all the many other conflicting interests in the present educational institutions in London fail to recognise that the greatest good for themselves lies in the consolidation rather than in the separation of their efforts. The London University, it may be said without exaggeration, has never had a real chance, and once again it seems to have reached another of those ever-recurring crises in its history. Taken in hand in the proper way, the many obstacles which now retard its proper development can, we feel sure, be overcome, and it would be a great pity if the authorities of the Imperial College for sectional reasons did anything to prevent this. We have already examined in detail and traversed the claim of the Imperial College to the University status, as evidenced by the power to grant its own degrees. In all except this shadowy honour it already has that status. The one real grievance is that students without passing two sets of examinations cannot obtain the degree, and that without the degree they are handicapped in after life. But surely this could be arranged at a round-table conference, given the necessary preliminary that each side was willing to see the best in the other's case. The University of London itself is admittedly in need of reform, but this can best be brought about by conciliation and association rather than by secession. We hope that on maturer consideration the Imperial College authorities will come round to this view, and that resolutions, threats and fiery talk will give way to attempts to find some more peaceful way out of present difficulties.

The Social Bases of Wage Advances.

IN awarding advances of wages to the railwaymen, varying from 7s. 6d. to 2s. per week, the National (Railway) Wages Board makes some trenchant comments to which wide publicity may well be given. It is clear, they point out, that these latest claims were not made on account of the increased cost of living, but because the difference between the railwaymen's own wages and those of the dockers, miners, policemen and municipal workers had been decreased by recent decisions. As we pointed out last week, this is no good and sufficient reason for an increase, but so long as these wages questions are considered by trades, instead of as a whole, so long will it be possible for such arguments to be advanced with some show of justice, with the inevitable result that claim follows claim, and wages and the cost of living rise higher. It is, therefore, now more than ever necessary that this piecemeal settlement of wage demands should cease, and that some central authority should be set up to examine all claims. Only thus is there any hope of a consistent course being followed.

Railway Wages and Costs.

NATURALLY the first result of the present concession will be an addition to the railway wages bill of some £10,000,000 per annum and the sliding scale increases and the extra cost of materials and fuel will probably account for another £21,500,000 to cover which either passenger fares and goods rates will have to be increased with a further corresponding increase in the cost of living, or the railways will have to be run at a loss. The advance in rates necessary to enable railways to earn their present dividends with the new charges would probably be in the neighbourhood of 20 per cent., making an addition of 90 per cent. to pre-war rates, but as this only gives the very low rate of interest of 3·64 per cent. the companies might well, on their side, put forward a claim to a higher return to compensate for the increased cost of living. On strict grounds of justice it would be very difficult to deny them.

The Passing of the Railway.

THERE is another side to this question which has not received the consideration it deserves. The present high rates and the delays caused by the ca'canny policy, whether openly or overtly conducted, are causing traders more and more to use the roads rather than the railways. Still higher charges for railway carriage will only increase that tendency, and may even cause certain important industries to collapse, which would be good neither for the railwaymen nor for Labour generally. And higher wages are of little use when prices are higher still, and they are still less good when they mean unemployment. Even railway companies might come round to the view that it would be better to collapse than to pay exorbitantly for less work, and we hope therefore for their own sakes the railwaymen will see that the view expressed by the Board that "the settlement should not be disturbed for such period as will facilitate a return to that stability of industry and commerce which is so necessary to the well-being of the community," is the only sane one at the present time. We may expect the usual outcry against the agreement that has been arrived at, but we hope that the members will pause and consider whether these constantly recurring claims, which never catch up the cost of living, are really worth while, and whether the time has not now come soberly to settle down to steady work. We are glad to see that Mr. J. H. THOMAS takes this view, but we are afraid he will have some little difficulty in imposing it upon his followers. The strength of the monster that Frankenstein raised is as nothing compared with that of the hydra created by Mr. THOMAS and other lights of the Trades Union movement, and its strength is only equalled by its seeming inability to perceive what is for its own good. Unless these frequent wages demands cease, the country will never recover its industrial stability. When a man is poisoned he is given an emetic until the poison is eradicated, but emetics are weakening, so that once they have done their work their use is dropped, and the patient is allowed to rest so that his system may recover. Our industrial system has been poisoned, the poison has been eradicated, and now it wants rest badly or a collapse is inevitable.

Sir Dugald Clerk Again!

REITERATION, it has been said, is the soul of propaganda. Sir DUGALD CLERK and those who are supporting him evidently agree with this dictum. For they repeat loudly and often that gas is more efficient as a generator of heat than electricity, and that to build sixteen super-electricity stations instead of an equal number of super-gas works is a wicked and wilful waste of public money. Whether it is quite in accordance with the best traditions of professional conduct for an engineer of eminence to use the James Forrest lecture as a vehicle for statements of this kind or to employ the presidential chair of the Institution of Gas Engineers as a platform for preaching such doctrines, is not for us to decide. It certainly has the excuse that it has attracted the attention of "The Times," who is so far enamoured of the ideas put forward as to have called mildly approving attention to them in a Leading Article. Now there was a time when our contemporary's Leading Articles had all the infallibility of a Papal Bull, and when it weighed judicially the pros and cons of each question upon which it pronounced. We fear that day has passed, and that other considerations now guide the pens of its writers. And without wishing to be unkind, we may hazard the view that its championship of gas is less dictated by a conviction that this agent is the best that its public can use for heating purposes, than by a desire to condemn the Government for wasting public money in building sixteen enormous generating stations. The fact that it has been stated over and over again that the Government (no later than last week Sir JOHN SNELL himself made a definite statement on the point) has no such idea, is too minor a matter of which to take cognisance.

Why Electrical Engineers Must Take Notice.

IT may be thought that those electrical engineers who are now so busy manufacturing electrical apparatus or connecting fresh consumers to their mains rather more quickly than is altogether good for their peace of mind, can afford to neglect this sort of thing. But this is not so. While the effect of such propaganda is often little apparent at first, it is nevertheless most insidious. The public considered in the atomic form, rather than in the mass, place great reliance on what they read in the newspapers. Gas engineers have long taken advantage of this, and it is time electrical engineers followed their example. For while it is doubtless regrettable that some at least of what appears in the editorial columns of our newspapers is a mere reflection of what is to be found in the advertising columns of the same Papers, it is a state of things which has its uses. But important as all this is, the technical side of Sir DUGALD CLERK'S arguments must not be neglected. His figures must be dealt with and controverted. Fortunately he is giving us the opportunity, and when he reads his Paper on the "Distribution of Heat, Light and Motive Power by Gas and Electricity" before the Institution of Electrical Engineers next week he will doubtless have put before him evidence that will show him his views on thermal efficiency are based on a series of false premises. Our business then is to convince the general public of the strength of our case, and the longer we delay in so doing the harder it will be. At the present time there is generally an open mind on the relative merits of electricity and gas. But the gas interests are doing their best to alter that, and it is therefore all the more necessary that we should be quickly in the field.

The Tramway Settlement.

WE are glad that our pessimism regarding the outcome of the deliberations on the tramway wages has not been justified. On Friday agreement was arrived at; and it was announced that a flat rate increase of nine shillings per week would be granted in the London area (thus negativing the employers' proposal of a graded increase), and that graded increases of 7s., 8s. and 9s. per week would be adopted for the other districts on the basis of the Lancashire settlement. Each District Council will decide on the increase that each undertaking in its district is to receive, and in case of disagreement reference may be made to the National Industrial Council. So far then as the men insisted on a national settlement they have failed. We feel sure this is the right decision, and it is a little difficult to see the objection to it, except in so far as it is based on the feeling of injustice which arises from the thought that some one else is receiving more than they are. Unfortunately this is not an economically sound basis, and a better one is the consideration of the excess of income over expenditure rather than of receipts by themselves. It is obvious also that in any large town, and especially in London, the cost of living is likely to be higher than in a smaller town; so the decision has that much of elementary justice in it. The further argument that the work in the smaller towns is not so arduous has something to recommend it, though the differences are often not so great as is commonly supposed. But whatever the ethics of the sliding scale may be, this much is certain, unless the sorely harassed tramway undertakings are given a chance to settle down to steady working, many of them will cease to be able to pay wages at all, and many tramwaymen will then be left out in the cold.

A University and War Time Enterprise.

A week or two ago we called attention to an appeal which was being made by Mr. Sydney Walton through the means of a mock prospectus for further funds to enlarge the premises and to carry on the work of the University of Manchester. Having studied any real prospectus and diluted its glowing sentences with a certain amount of that scepticism which is one of our most useful weapons in present-day life, the next thing to do is to find out as much as possible about the work of the concern for which fresh capital is required. This procedure may well be followed in this case; and it is made easier by the publication of a report detailing the work done by the staff and students of the Manchester School of Technology during the war. A number of both naturally joined the technical branches of both the naval and military services, but a large amount of useful work still continued to be carried on at the College.

Submarine and Aeroplane Research.

During 1915 Prof. A. B. Field investigated certain problems in connection with the electrical equipment of aeroplanes and designed a new light type of high-frequency alternator for wireless air intercommunication. In conjunction with Mr. H. Carrington, Prof. Field also designed a 200-watt alternator, of which some thousands were made for aeroplane work, and a smaller machine driven by the propeller for supplying power to a gyrostat. Prof. Miles Walker devised a single-phase balancer to overcome certain difficulties which arose in connection with the supply of single-phase current to electric furnaces producing high-grade steel for munition work. He also invented an instrument for determining the acceleration of aeroplanes, and a deep-sea hydrophone to work at a very high hydrostatic pressure. In connection with Prof. Gerald Stoney he did a great deal of research into the methods of detecting and combating submarines, much of the apparatus for the purpose being designed in the college workshops. A large amount of similar valuable work was done in the metallurgical, chemical, dyestuffs and textile sections. It is a record of enterprise and endeavour of which the College may well be proud, and it is enterprise and endeavour of that kind which cannot be better rewarded than by subscribing to the fund that will make the continuance of such work possible.

A Dispute About Overtime.

It is becoming more and more the policy of the E.T.U. to copy the behaviour of the stage Irishman, and to butt into any industrial trouble that happens to be going, whether it affects their interests or not. The latest example of this policy is to be found at Sheffield, where trade is now suffering dislocation owing to a strike of the "steam service" men employed at the steel works. The trouble originally arose out of negotiations regarding the introduction of the three turn system. These negotiations have been proceeding for some twelve months, and finally five out of the six unions concerned came to an agreement with the employers, the Enginemen and Firemen's Union alone remaining irreconcilable. The employers, therefore, determined to put the agreement into operation, and in this they had the support of the five unions, with the result that the sixth union called its men out, and thereby caused an almost total stoppage in all the iron and steel works in the district, except those where electricity is extensively employed. With the causes of the dispute we are not concerned, but it is clear that what has happened exposes a fundamental weakness in the Trade Union movement, and one to which the saner elements would do well to give some attention. Incidentally it also exposes the hollowness of the arguments in favour of the shorter day and against overtime. To many the real object of a shorter day is not to have more time for recreation, but more time in which to earn overtime.

Untimely Interference.

Into this welter of confusion rushes the E.T.U., for reasons which must remain obscure. Probably one of them was "sympathy," and another that the Corporation generating plant was blacklegging. From the beginning, the movement was a failure. At Barnsley, Doncaster and Chesterfield similar failures to bring about a stoppage are reported, and the only place where anything like success was attained was at Rotherham, but there it was only ephemeral. The result is that Mr. Matthews, the local secretary of the E.T.U., is in dire disgrace, and really we are not surprised. For if nothing succeeds like success, nothing fails like failure. Surely it is time the E.T.U. recognised that it is not to their interest to strike, and threaten to strike for any and every reason. Meanwhile, though they have failed, the main stoppage still continues, and is having a most disastrous effect upon production and employment.

The Nuclear Constitution of the Atom.

In the course of the Bakerian Lecture which he delivered before the Royal Society last week, Sir Ernest Rutherford compared the structure of the atom to that of the solar system wherein the sun represents the positive nucleus, and the planets the negative electrons, the whole being held together by electrical instead of gravitational forces. The simile was the more realistic because the nucleus and electrons of the atom only occupy a definite region of atomic space, and do not fill it. With few exceptions the number of units in the nuclear charge is represented by the atomic number of the element, while all its chemical properties are determined by its nuclear charge, and only to a secondary extent by its mass and weight. Further light on this subject is thrown by recent experiments made by the lecturer in which hydrogen atoms were liberated from atoms of nitrogen together with atoms of a previously unknown element of mass 3, while in the case of oxygen atoms of the latter kind were alone observed. It is, therefore, a natural deduction that the hydrogen atoms and the atoms of the new element were parts of the original structure of the nucleus of nitrogen and oxygen. As Sir Ernest pointed out, this does not mean that nitrogen and oxygen are no longer elements in the ordinarily accepted sense, but simply that they can be broken down if a sufficiently powerful agent is brought to bear on them. The idea that the nuclei of all atoms of matter are built up of hydrogen or a combination of hydrogen with electrons, seems, therefore, to be justified, but at present the nucleus is an unknown region where the forces that bind its parts together are probably different both in degree and in kind from those that hold the external electrons found in the atom. Experiments and results such as these drive still further into the past the old theories of the indivisible atom, and help us to approach slowly, but still surely, the day when the ultimate constitution of matter will be a fact of general knowledge.

The National Electric Light Association.

The activities of the National Electric Light Association leave us breathless. During the greater part of the twelve months its operations are confined to sectional meetings, and to the organisation of various branches. It is then comparatively speaking quiescent, but with the quiescence of an inert volcano. Towards the end of March, however, the volcano begins to spout, and soon the whole of the electrical press of the United States is full of what the Association is doing, and of what it is going to do at the Annual Convention. As the time for the Convention approaches, the volcano becomes more and more active, and the lava which it ejects spreads even to such remote countries as our own, continuing to flow indeed until long after the meeting is over, and the volcano has returned to its state of somnolence until next year. For the past few days we have been receiving our share of the lava in the shape of addresses, reports, papers and official abstracts on all the many subjects which were dealt with at the meeting held at Passadena, California, last month. A perusal of them has led us to the conclusion that we have only to think of any subject remotely connected with electrical progress and welfare, to find it has been exhaustively, if not exhaustingly, dealt with by the N.E.L.A.

Inductive Interference.

One of the subjects which is dealt with in a Committee Report, and which is likely to become of increasing importance, both in the United States and in this country, is that of inductive interference. The report pleads for a more general and comprehensive study of the subject by all concerned. We agree that this should be done, while as far as the problem is considered purely from the technical side, any work carried out in the United States will help us, and the reverse will be equally true. Unfortunately in this country technical questions are not of so great importance as those of a legal character. In the United States the telegraph and telephone systems, which are, of course, the principal sufferers from inductive interference, are owned by private interests, and any regulations that are made will be made as the result of legislation or arbitration between two privately-owned concerns. In this country the telegraph and telephone lines are owned by the State, and the relation between the Government Department and the private interests concerned is as a result not unlike that of the panther and the owl when it came to sharing the pie. We do not want to see the development of power supply in this country retarded by bureaucratic influences (that would be worse than inductive interference), and that can best be avoided by supply undertakings investigating this question as closely as possible, and laying down for themselves the lines which protection should take.

The Industrial League and Council.

The Report of the Industrial League and Council for the six months ending March 31st, 1920, shows that this body is still carrying on its good work of effecting a more complete understanding of the differences that seem to be always recurring between the various sections of the industry. This period also marks the first six months of the work of the amalgamated Industrial League and Industrial Reconstruction Council, and we are glad to learn that this movement towards closer union has been attended by complete success. This success is an indication that fusion with other similar bodies would be good policy. We have now a number of interests working with very similar aims, and with differences in constitution so small as to be almost invisible to any one except their own members. It is desirable that these small interests should be combined into one big whole, for thereby not only is energy and money saved, but very much greater results are obtained. If the Industrial League and Council can effect some such amalgamation they will crown the excellent work they have already done.

Submarine Intercommunication.

An Interesting Compromise.

The effect of the increasing development of wireless telegraphy on the prosperity of the older cable companies is a matter about which there is a good deal of speculation. These concerns are indeed in a very difficult position, for the war not only made impossible the periodical repair of their cables, but prevented the laying of new ones. On the other hand, traffic over the existing cables has grown to an unprecedented extent, while wages and costs of all kinds have advanced to a high figure and there must be a limit to increases in receipts The obvious way of altering this state of things is by laying more and still more cables. Unfortunately, the manufacture and laying of submarine cables takes time, apart from the large capital expenditure which it must involve, and though the cable companies are doing what they can in this direction, what has been done and what is likely to be done will do little to relieve the congestion for some considerable time in the means available for international inter-communication.

Some Obstacles to International Wireless.

As adequate international communication is an essential of present-day existence it may be asked why wireless telegraphy should not be more employed for this purpose. But wireless telegraphy has its own troubles, not the least of which are those connected with finance, while the overall efficiency of the system is low and the construction of stations and the development of systems are not matters that can be successfully concluded in a day. While, therefore, there is every hope that the employment of wireless methods will go on increasing and that this increase will be assisted by the improvements which will certainly be made in the apparatus, for the moment it cannot take its full share in solving the problem of international intercommunication.

A Possible Way Out of the Deadlock.

It would therefore seem as if a virtual deadlock had been reached when the older system has done as much as it can do and the newer system is not yet ready to do all it will do. If this represents the true state of affairs the best we can hope for is that the work which is now being done to bring back our international communications to their old state of efficiency will not be too long delayed. But there would seem to be another way. Necessity is the mother of invention. And once again invention is playing its part. For while not wishing to be too optimistic, some experiments made by Major-General G. O. Squier, a description of which will be found on another page of this issue, point a road out of the difficulty.

Curiously enough the invention itself arose from necessity of another kind. During the war the Signal Corps of the United States Army experienced considerable difficulty in obtaining insulated wire, because sufficient braiding machines could not be made in the time. On the other hand, there was no difficulty in obtaining bare wire, and it was obvious that if this could be used for telegraphic and telephonic purposes in the field, not only could the badly needed wire be obtained but money and weight would be saved. When it is stated that the amount of insulated wire required by the American Armies in the field was 40,000 miles a month, weighing about 14,000 ship tons, and that the same length of bare wire required only 2,500 ship tons, it is obvious the use of the latter would have meant a considerable release of tonnage for other uses. Any means whereby bare wire could be substituted for covered wire would, therefore, be of the greatest value, and experiments were accordingly made to see whether such were possible.

Lessons from Submarine Communication.

As is well known, it is possible for two submerged submarines to communicate by ordinary wireless methods, and tests were therefore made to see if this communication would be improved by connecting two ships by a wire. As General Squier points out, if this arrangement were successful it probably follows that the overall efficiency of transmission would be greater than with ordinary wireless methods, while at the same time the three electrode valve could be usefully employed.

Some Interesting Experiments.

Experiments conducted by the U.S. Signal Corps authorities showed that these suppositions were correct and they also demonstrated the possibility of transmitting electromagnetic waves along bare wires submerged in water. Further investigations into this subject are now being carried out, and though the phenomena associated with this work are still obscure and Major-General Squier and his assistants have up to now not even gone the length of formulating a theory on the subject, it will be agreed that the idea is one not only of great scientific interest but of extreme practical importance in its ultimate development on the lines which we have indicated above. The experiments are, of course, a development of the "wired-wireless" investigations with which General Squier's name has been associated for some years.

As will be seen in the more detailed account which we give, satisfactory communication was established with wires buried in the earth and immersed in water. So far, of course, the distances traversed by this method have been small, but there seems no reason at present why these should not be increased to any reasonable extent. The difficulties that arise under similar conditions with ordinary submarine telegraphy do not occur in this instance. There are not, for instance, the same limitations of pressure and current, and indeed it would seem possible to use currents of any convenient value depending on the length of the line that is being operated. Further, such an arrangement introduces the possibility of submarine telephony which is quite precluded at the present time for international intercommunication.

The Consumers' Strike.

A strike on the part of the consuming public may be said to have begun and to be spreading very rapidly. If this movement had started 18 months ago, or even during the war itself, it would have saved us a good deal of trouble, for the determination of the consumer to consume and the buyer to buy has been the main cause of the continual rise in all prices during the last few years. The public is gradually awakening to this truth as it realises the futility of attempts to stop what is called "profiteering," and is coming to see that the only power which can regulate a price is the willingness or unwillingness of the buyer to pay it.

Main Features of the Changes.

The consumers' strike is, therefore, very welcome provided that it proceeds leisurely and does not go too far. The economic organism is so elastic and adaptable that it can accommodate itself to almost any circumstances, so long as the changes to which it is submitted are sufficiently gradual, and so long as it is preserved from severe shocks. It is highly desirable that we should all realise to the full the main features of the changes that have taken place and the lines along which further change is desirable.

In the last few years we have doubled and trebled values of every kind. We express this movement in our Irish way by saying that the sovereign is worth 8s. 6d. By gradual stages the sovereign has slowly depreciated in value until to-day goods, which before the war would have been marked 8s. 6d., are now ticketed £1. This process has been going on for about five years, which means that the sovereign has gone down by 2d. or 3d. a month. We have now got to get the £1 sterling back to parity, and it would be an advantage to everyone if that process could be carried out rather less rapidly than was the reverse operation.

The Rise in Prices and the Aftermath.

The steady rise in the value of commodities and in wages and prices generally has had at least one advantage; it has given to us all an appearance of prosperity; it has almost shut up the Bankruptcy Court, and, indeed, if we could arrange the world so that prices would never cease rising, most of the objections to inflation would disappear. But the trouble is that inflation must be followed by deflation; rises must be succeeded by falls, high prices must be the precursors of falling markets, and these falls are very dangerous things; they bring in their train bankruptcy, unemployment and financial crises. These evils are accentuated if the fall is sudden or deep.

Gradual Reduction an Ideal.

Thus we begin to see the ideal arrangement, if it were possible to work this great thing out in the ideal way. We have knocked the sovereign down 2d. or 3d. a month; if we can put it up again at the rate of 1d. or 2d. a month, at a rather slower rate than we knocked it down, our difficulties would be minimised very considerably. Thus we are constrained to ask that the consumers' strike, which is a healthy, necessary and proper procedure, should be applied gently, gradually and leisurely. If the consumer declines to buy existing stocks at present prices he will force large numbers of workmen into unemployment; if he insists upon drastic reductions in prices, he will force large numbers of manufacturers and merchants into bankruptcy. If, on the other hand, he is content with a gradual price reduction, he will enable the holders of stocks to negotiate their moderate losses and will give time to manufacturers and to Labour so to reduce prices by increasing output as to bring them down by degrees to normal.

Labour's Perilous Situation.

From the Labour point of view the situation is perilous and unprecedented, and requires handling with skilful statesmanship. If Labour continues to push up wages and push down output, prices will get worse and the consumers' strike will become more determined; wholesale bankruptcy and unemployment is the inevitable outcome of any such policy. If, on the other hand, Labour will, before it is too late, turn its attention to output, it can so reduce prices as to meet and stultify the consumers' strike.

The Consumers' Right Position.

It can, indeed, do better: it can promote demand, which always follows lower values. The consumer is at last coming back into his right position. For years everything has been fixed on the assumption that he would do just what he was told; he has been rationed, controlled and ordered: he has been told exactly how many ounces of everything he might have; exactly where he might purchase it and exactly what he must pay. At last he is beginning to wake up to the fact that he is the real master of the situation: that an article is only worth what it will fetch, and that all the Controllers or Ministries or Soviets on earth cannot force him to buy a single ounce of tobacco or a single pair of boots unless he is so inclined. As this fundamental truth dawns in the minds of the world's consumers, so industry will become normal, natural and free.

But the process must be gradual, otherwise we shall have bank crises and unemployment.

Electric Winding Engines and Mine Hoists.[*]

By H. H. BROUGHTON.

(*Continued from page* 615.)

Ward Leonard Winder for Compound Shaft.

Example.—Data are given below of a 10,000 lb. rock hoist for a compound shaft. The hoist is required to work indefinitely either balanced or unbalanced (*a*) from the full depth, and (*b*) from the bottom of the vertical shaft. It is required to determine the constants of the electrical machinery and to predict the power consumption.

The principal data are :—

Rock	10,000 lb.
Skip	7,500 lb.
Shaft (Fig. 25)	1,010 ft. vertical. 3,000 ft. (+280 ft.) inclined at 33 deg.
Rope	$1\frac{1}{4}$ in. dia. ; 2·5 lb. per ft.
Output per hour	100 tons.
Maximum speed	2,500 ft. per min.
Speed round bend	1,500 ft. per min.
Drums	Twin cylindrical 10 ft. dia. × 6 ft. wide. Inertia $WR^2 \div g = 45{,}000$.
Sheaves	$WR^2 \div g = 9{,}000$.
Loading time	30 sec.

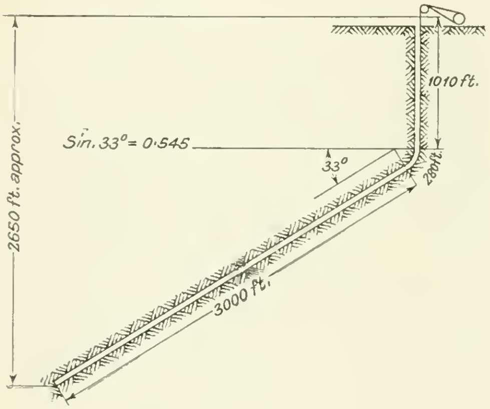

Fig. 25.—Compound Shaft.

The diagrams are to be drawn from the data specified ; the allowance for friction to be as follows :—

Rolling-friction coefficient	tan 2°
Rope friction in incline	4 per cent.
Shaft friction................................	5·2 per cent. in incline. 5·6 per cent. in vertical.
Efficiency of drums and sheaves ...	98 per cent.

Since the determination of the torque diagram for a hoist of this kind has already been fully described in these articles[†] we shall, for the present, confine ourselves to the outline calculations so as to give the reader an opportunity of testing his knowledge.

Approximate Motor Output.—Traversing a shaft 4,290 ft. in length at a speed of 41·7 ft. per second would take 103 sec., and in this time a nett load of 10,000 lb. would be lifted vertically about 2,650 ft. The work done per second is, therefore, $10{,}000 \times 2{,}650 \div 103 = 257{,}000$ ft. lb., and the corresponding horse-power $= 257{,}000 \div 550 = 468$. Multiplying this figure by *two*, the probable rating of the motor is found to be 940 H.P.

Drum Speed.—To coil a 4,290-ft. length of rope on a drum 10 ft. in diameter requires $4{,}290 \div 10\pi = 136$ turns ; and, since a drum 6 ft. in width will carry 52 turns of rope pitched $1\frac{3}{8}$ in., it follows there will be $136 \div 52 = 2\cdot6$ layers of rope on the drum. Hence the mean diameter of the drums is about 10·3 ft. and, for a rope speed of 2,500 ft. per min., the corresponding drum speed $= 2{,}500 \div 10\cdot3\pi = 77$ revs. per min.

Probable Constants of Motor.—A 940 H.P. motor running at 77 revs. per min. will have an armature of about 17·5 tons in weight and 9·5 ft. in diameter. The probable inertia $= WR^2 \div g$ of such an armature will be 15,400.

Subdivision of Cycle.—For balanced hoisting from full depth an hourly output of 100 tons, at 10,000 lb. per wind, necessitates :—$100 \times 2{,}240 \div 10{,}000 = 22\cdot4$ winds per hour each of $3{,}600 \div 22\cdot4 = 162$ sec. duration. When winding under these conditions the nett winding time is, therefore, $162 - 30 = 132$ sec., and this is divided as follows :—

Period.	Duration, sec.	Distance travelled, ft.
Initial acceleration	15·0	313
First constant speed	8·7	354
First retardation	10·0	333
First reduced speed round bend	11·2	280
First re-acceleration	10·0	333
Second constant speed	25·0	1,040
Second retardation	10·0	333
Second reduced speed round bend ...	11·2	280
Second re-acceleration	10·0	333
Third constant speed	11·2	467
Final retardation	10·0	208
Totals	132·3	4,274

Static Forces—

Ropes : Rope pull in vertical $= 1{,}010 \times 2\cdot5 = 2{,}525$ lb.

,, ,, on incline $= 3{,}280 \times 2\cdot5 \times 0\cdot545 = 4{,}460$ lb.

Ascending Skip : When skip is on the incline,

$$\text{Rope pull} = (10{,}000 + 7{,}500)(0\cdot545 + 0\cdot03)$$
$$= 10{,}070 \text{ lb.},$$

and when the skip is in the vertical portion of the shaft,

$$\text{Rope pull} = 10{,}000 + 7{,}500$$
$$= 17{,}500 \text{ lb.}$$

Descending Skip : When skip is on the incline,

$$\text{Rope pull} = 7{,}500(0\cdot545 - 0\cdot03)$$
$$= 3{,}860 \text{ lb.},$$

and when skip is in the vertical,

$$\text{Rope pull} = 7{,}500 \text{ lb.}$$

Friction : For rope friction we have to allow 4 per cent. of the weight of rope in the inclined portion of the shaft. Since the maximum weight of inclined rope is $3{,}280 \times 2\cdot5 = 8{,}200$ lb., the friction allowance is, therefore, $8{,}200 \times 0\cdot04 = 328$ lb.

For general shaft friction the allowances are : 5·6 per cent. for the vertical portion, and 5·2 per cent. for the inclined portion. The corresponding rope pulls due to shaft friction are, therefore,

Loaded skip on incline $= 0\cdot052 \times 17{,}500 = 910$ lb.
,, ,, in vertical $= 0\cdot056 \times 17{,}500 = 980$ lb.
Empty skip on incline $= 0\cdot052 \times 7{,}500 = 390$ lb.
,, ,, in vertical $= 0\cdot056 \times 7{,}500 = 420$ lb.

Dynamic Forces.—The equivalent masses at the mean drum radius, namely, 5·15 ft., are :—

	Balanced.	Lifting.	Lowering.
Motor armature $= 15{,}400 \div 5\cdot15^2$ ...	580	580	580
Drums and clutches $= 45{,}000 \div 5\cdot15^2$	1,700	1,060	1,060
Sheaves $= 9{,}000 \div 5\cdot15^2$	340	170	170
Ropes $= 2 \times 4{,}500 \times \cdot5 \div 32\cdot2$ ...	700	350	350
Ascending skip and load $= 17{,}500 \div 32\cdot2$	543	543	...
Descending skip $= 7{,}500 \div 32\cdot2$ ...	233	...	233
Total equivalent mass M ...	4,096	2,703	2,393
$Mv_1 = M \times 2{,}500 \div 60 = 41\cdot7\,M =$	171,000	112,500	100,000
$Mv_2 = M \times 1{,}500 \div 60 = 25\,M =$	102,400	67,500	58,500
$M(v_1 - v_2) = 16\cdot7\,M =$	68,600	45,000	41,500

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[*] Copyright. All rights reserved.

[†] The Electrician, April 23 and May 7, 1920.

The several accelerating and retarding forces, found by dividing the change of momentum by the time, are, therefore,

—	lb.	lb.	lb.
Initial acceleration, 15 sec.... ...	11,400	7,500	6,670
First and second retardn. and re-acceln., 10 sec.	6,860	4,500	4,150
Final retardation, 10 sec.	17,100	11,250	10,000

The foregoing calculations are sufficient to enable the reader to plot diagrams showing the unbalanced pull at every instant for the four cases of balanced and unbalanced hoisting. Those who intend to do the work for themselves are advised to plot the diagrams on squared paper (preferably ruled in mm.), so as to save time in vertical and horizontal projection.

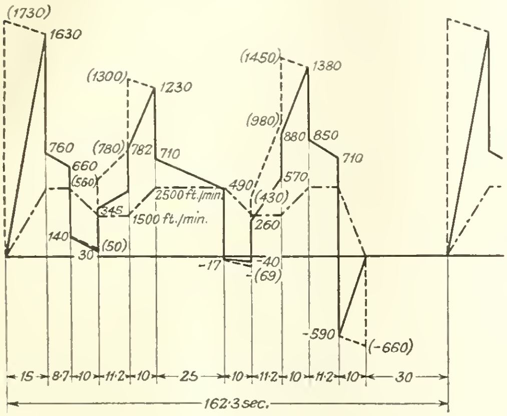

Fig. 26.—Power Diagram. Balanced Winding from Full Depth.

As yet no attention has been paid to the efficiency of the drums and sheaves which, in the specification, is given as 98 per cent. If at any instant the unbalanced pull is $+F$, then the actual nett force to be exerted at the mean periphery of the drum is $F \div 0{\cdot}98 = 1{\cdot}02F$; and if the unbalanced pull is $-F$, then the actual nett force is $-0{\cdot}98F$.

Knowing the nett force and the mean radius of the drum, the four diagrams are quickly converted into torque diagrams; and, since the drum speed is known, the cardinal points of the diagram can be figured in horse-power for determining the rating of the winder motor. As the maximum speed of the drum is 77 revs. per min., for any value of torque, say T lb. ft., the corresponding H.P. $= T \times 2\pi \times 77 \div 33{,}000 = 0{\cdot}00146T$.

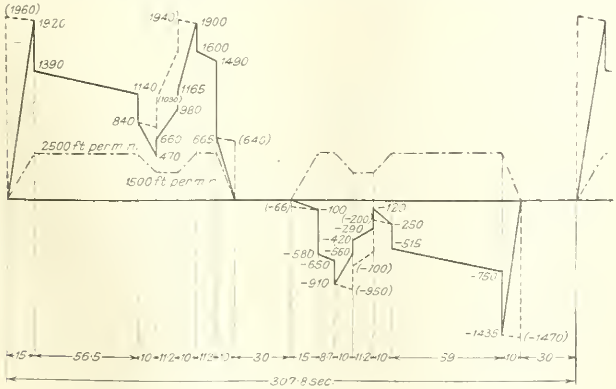

Fig. 27.—Power Diagram. Unbalanced Winding from Full Depth.

Power Diagrams.—The diagrams for the four conditions are given in Figs. 26 to 29. From these, by using the equivalent full-speed time values of the cycles entered on the diagrams, the virtual rating of the motor is found. For convenience, the equivalent times and ratings are tabulated below:

Conditions.	Equiv. time T_e sec.	Virtual rating H.P.
1. Balanced hoisting from full depth ...	125·5	955
2. Unbalanced hoisting from full depth	249·7	1,100
3. Balanced hoisting from bottom of vertical shaft	45·5	1,220
4. Unbalanced hoisting from bottom of vertical shaft	91	1,180

Attention should be drawn to the fact that the virtual rating is smaller for winding under unbalanced conditions than it is for winding under balanced conditions from the bottom of the vertical shaft. As the electrical equipments must be capable of winding continuously under balanced conditions from the bottom of the vertical portion of the shaft, they will also be capable of winding continuously under unbalanced conditions from any portion of the shaft; that is, provided the friction does not exceed the value given in the specification, which is understood for normal conditions.

Winder Motor.—This would be of the commutating-pole type having a virtual rating of 1,200 H.P., and a peak rating of 2,650 H.P., and running at a full speed of 77 revs. per min. It would be designed for a potential at the brushes of - 500 volts, and an excitation pressure of 220 volts. For excitation of the field winding about 11 kw. would be required. Subject to the usual tolerances, the efficiencies at various loads would be:—

Load	2/1	3/2	1/1	3/4	1/2
Efficiency, per cent. ...	90·75	92·25	93	92·75	92

These figures are plotted in Fig. 30 (*a*), and in the same diagram is given the loss-load curve. Knowing the motor output at any instant, the motor input (which is, of course, the starting dynamo output) can be found by adding the known loss.

Starting Dynamo.—Since the rating of the equipment is determined by balanced hoisting from the bottom of the vertical shaft, it will suffice for the present if we consider this condition.

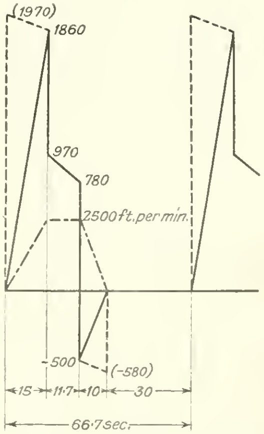

Fig. 28.—Power Diagram. Balanced Winding in Vertical Portion.

Starting Dynamo.—The diagram Fig. 28 has been re-plotted in Fig. 31, and is lettered *OAB . . . FGO*. Each ordinate of this diagram has been increased by adding the loss obtained by inspection from Fig. 30 (*a*), and the resulting diagram *OHJ* . . . . *NGO* represents the winder motor input or the starting dynamo output (for rating). Bearing in mind that the starting dynamo is running at practically constant speed the whole time, which means that the equivalent full-speed time is equal to the actual running time, namely, 66·7 sec., the rating of the machine is found to be 1,100 H.P. or 820 kw. It will be remembered that the rating of the motor which this machine supplies is 1,200 H.P. In other words, a constantly running dynamo rated at 1,100 H.P. is amply large enough to supply an intermittently-running motor rated at 1,200 H.P., the temperature rise being the same in both cases.

The starting dynamo put forward for this winder had compensating windings and interpoles. Like the winder motor it was designed for an excitation pressure of 220 volts, and the excitation at this voltage amounted to 7·2 kw. The efficiencies are :—

Load	2/1	3/2	1/1	3/4	1/2
Efficiency, per cent. ...	93	93·4	93	92·7	92

and these are plotted in Fig. 30 (*b*), along with the load-loss curve.

Main Motor.—Knowing the starting-dynamo output at any instant the loss at the instant is known, and hence the dynamo input, which is, of course, the main motor output, can be found. Remembering that although the very heavy output *OH*, Fig. 31, is current output and, as such, heats up the starting dynamo, the output of the main motor at the beginning of the wind is, nevertheless, small and there is no sustained heavy current input to the main motor during the starting period.

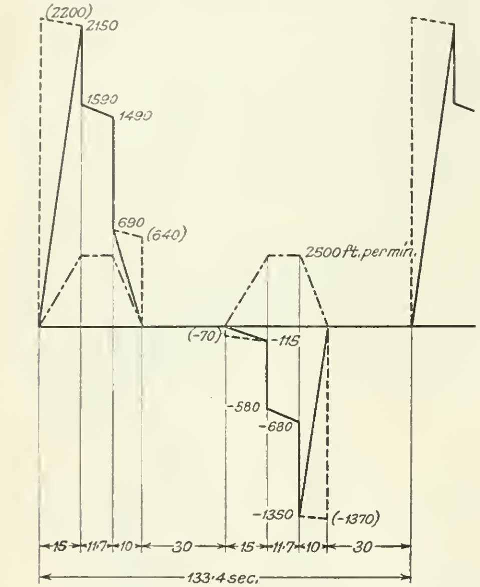

Fig. 29.—Power Diagram. Unbalanced Winding in Vertical Portion.

The diagram *OPQR* . . . . . *TUV* represents the main motor output and from this diagram the rating is found to be about 800 H.P. The maximum peak occurs at the end of the accelerating period, namely, *Q*, and is equal to 2,200 H.P. A ratio of 2,200/800 = 2·75 is too high a value for a commercial induction motor, and it is better practice to use a ratio not greater than 2·2 to 1, and this corresponds to a rating of 1,000 H.P. For a machine of this size a ratio of breakdown torque÷normal torque = 2·5 can be obtained, so that there will be a reasonable margin.

The motor is wound for a theoretical speed of 600 revs. per min., and a three-phase power supply of 2,000 volts, 50 cycles. At standstill, the rotor potential with an open rotor circuit is 1,150 volts, and at full load the rotor current is 400 amperes. With short-circuited rotor the slip at full load is 1·1 per cent

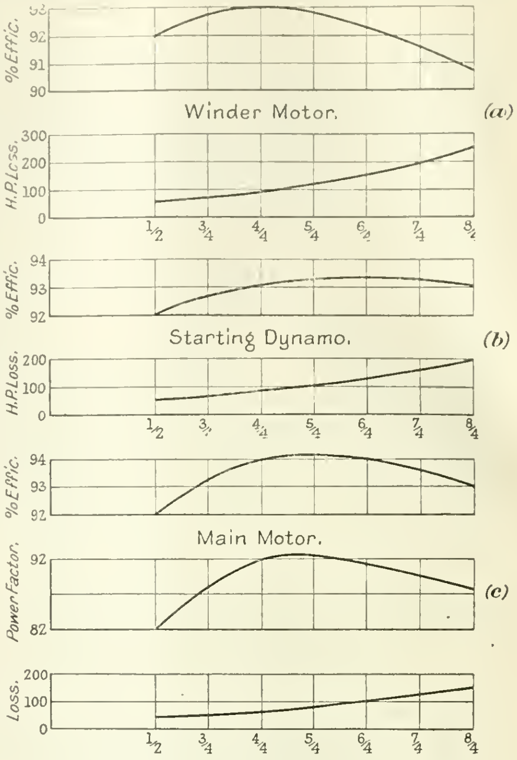

Fig. 30.—Performance Curves of Electrical Equipment.

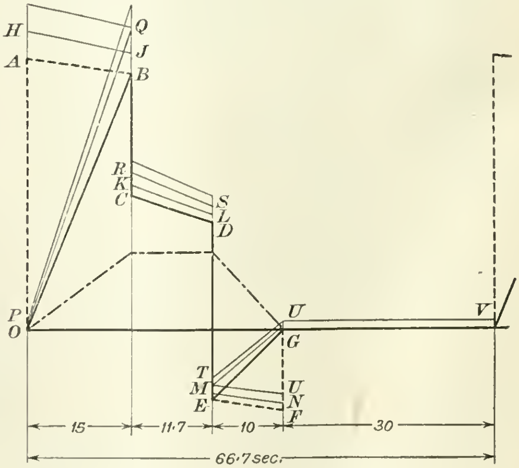

Fig 31.—Input and Output Curves.

The air gap per side is 1·75 mm., and the characteristics of the motor are :—

Load	2/1	3/2	1/1	3/4	1/2
Efficiency, per cent. ...	93	94	94	93·25	92
Power factor	0·88	0·91	0·92	0·88	0·82

These are plotted in Fig. 30 (*c*), and in the same diagram is shown the loss-load curve.

Knowing the output of the motor and the loss, the motor input at every instant throughout the wind can be found, and from this the power consumption and efficiency are determined.

Taking into account the efficiencies of the individual machines of the winding plant, the following figures are obtained for the power consumption for the several diagrams, Figs. 26 to 29.

For Constant Hoisting.

Diagram.	Kw. hours per trip.	Mean Kw.	Shaft H.P.	Kw. per shaft H.P.
Fig. 87	19·0	420	300	1·40
88	25·3	296	160	1·85
89	6·4	345	280	1·23
90	7·9	214	140	1·53

The above values, which are understood with a margin of ±5 per cent., are probably near the mark as long as the friction allowances are not exceeded.

(*To be continued.*)

Multiplex Telephony and Telegraphy Over Open-Circuit Bare Wires.*

By Major-General **GEORGE O. SQUIER.**
(Chief Signal Officer, United States Army.)

The "key problem" in the procurement of essential Signal Corps supplies in the United States during the World War curiously enough turned out to be the production of the necessary braiding machines for finishing insulated wire. The bare wire itself could be obtained, the rubber insulation could be obtained, even the cotton thread with which the braiding was made could be obtained, but the necessary machinery for braiding the thread, which finally led us into the intricacies of the procurement of steel, was never anything like adequate for the enormous demands required in the field.

The braiding capacity of the entire United States, as on September 1, 1918, was about 8,000 miles of twisted pair insulated wire per month, while the requirements for the American forces alone at that date were about 40,000 miles a month. On October 1, 1918, the Allied Council reached the decision that beginning March 1, 1919, it would be necessary for the United States to furnish all of this type of wire used by the Allied armies in the field, and the estimated minimum requirements for this purpose were equivalent to four times around the earth a month. To supply this amount of insulated wire would have required cargo space for overseas shipment in the amount of 14,000 ship tons a month, but had it been possible to use single conductor bare wire in place of the twisted pair insulated wire, the space required would have been reduced to 2,500 ship tons a month, thus releasing the balance for transportation of food, and other vitally necessary supplies.

The above facts show the necessity of developing, if possible, new methods by which a reduction may be effected in the enormous quantities of expensive and bulky insulated wire, which was so difficult to procure, and which must now be buried in the earth to a depth of 8 ft. or 10 ft. throughout the advance sectors of the front line of a modern army.

Three Media for Electric Wave Propagation.

The following reasoning led to the carrying out of the experiments to be described:

1. Since we can already communicate by radio means between one submarine and another submarine, both completely submerged, it was considered that connecting two such stations by a submerged copper wire could have no other effect than to facilitate the propagation of the electric waves between the stations.
2. It was considered possible that the behaviour of earth or water under the action of high-frequency currents might exhibit greatly different properties from those with which we are familiar at direct or low-frequency currents.
3. It was realised that whatever high-frequency energy losses might occur in the case of bare wires laid in earth or water, yet the over-all efficiency would be higher than in the case of radio space transmission where the plant efficiency is so very low.
4. It was noted by the writer in September, 1910, and discussed by him in April, 1912,† that the three electrode audion could be used as a potentially-operated device on open circuits. This arrangement was considered suitable for the reception of the signals over bare wires in earth or water.

Preliminary Experiments.

The first experiment was an extremely simple one: A bare No. 18 phosphor-bronze wire, such as is used for the Signal Corps field antenna, was laid across the Washington Channel of the Potomac River from the War College to the opposite shore in Potomac Park. It was paid out from a small boat with sufficient slack to lay on the bottom of the river. A standard Signal Corps radio telephone and telegraph set was directly connected to each end of the wire, one set serving as a transmitter and the other as a receiver. At the receiving end of the line the bare wire was directly connected to the grid of the receiving set, and the usual ground connection left open. A frequency of about 600,000 cycles a second was used, and the line tuned at each end by the usual methods. Excellent telegraphy and telephony were obtained. Care was taken to make this preliminary experiment as simple and basic as possible, and precautions were taken to insure that the wire itself should be bright and clean and entirely free from any grease or other insulating material.

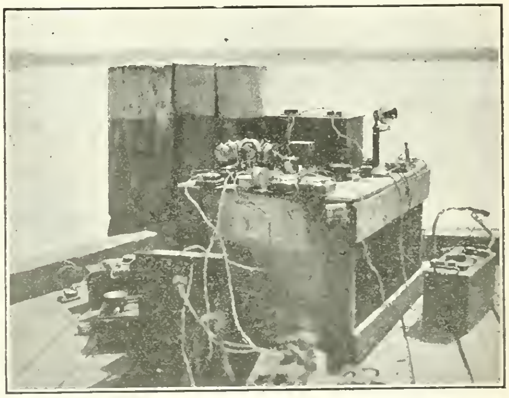

Fig. 1.—Transmitter Used in Submarine Wired Wireless Experiments between Fort Hunt, Virginia, and Fort Washington, Maryland, April 15, 1920.

The bare wire over which the signals were sent is seen going over the edge of the dock at the left of the picture.

The success of this simple experiment immediately led to a more thorough consideration of the entire subject. One of the questions to be investigated was the general efficiency of the electron tube when used as a potentially-operated instrument. The following experiment was made: A strip of wire netting was buried in the snow outside the office of the Chief Signal Officer in Washington, and a wire attached thereto, leading to the second story of the building. The upper end of this wire was connected directly to the grid of an electron tube. The reason for connecting the grid to the upper end of the antenna is, of course, obvious, if we are to use the tube as a potentially operated device. It was necessary for maximum sensitiveness to connect it to the point of maximum potential of the antenna, which in the case of a linear oscillator occurs at the open end. By this arrangement, messages were readily received from distant points in the United States.

These two simple experiments, above described, demonstrated the possibility of transmitting electromagnetic waves along bare wires submerged in water, and the use of an electron tube as a potentially-operated device for the reception of signals.

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* Abstract of a Paper read before the National Academy of Sciences, Washington.

† "Journal" of The Franklin Institute, April, 1912, "Some Experiments in 'Wired Wireless' Telegraphy for Field Lines of Information for Military Purposes," by Major George O. Squier, Signal Corps, U.S. Army. The Electrician, Vol. LXIX., p. 487, June 28, 1912.

FURTHER DEVELOPMENTS.

For military reasons, if for no other, as stated in the introduction of this Paper, the Signal Corps has recently undertaken certain investigations in the phenomena connected with the transmission of high-frequency electromagnetic waves over bare wires in earth and in water.

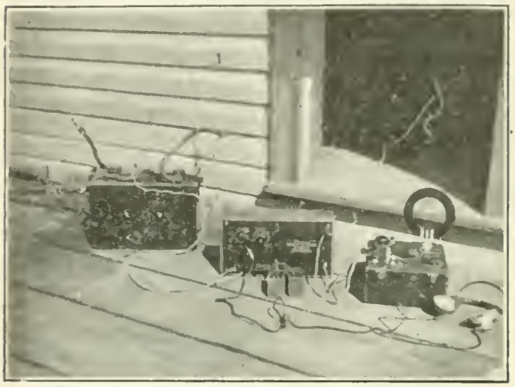

FIG. 2.—RECEIVING APPARATUS USED AT FORT WASHINGTON, MARYLAND, IN SUBMARINE WIRED WIRELESS EXPERIMENTS OF APRIL 15, 1920.

In carrying out these investigations and in attacking the problems from various angles, the research staff of the Signal Corps laboratory at Camp Alfred Vail, Little Silver, New Jersey, was directed to carry out experiments on bare wires laid on the surface of moist ground, and also buried in earth. The staff at the Signal Corps research laboratory at the Bureau of Standards was directed to investigate fundamentally the transmission of electromagnetic waves over bare wires in fresh water. In addition to this, the engineering staff of the Office of the Chief Signal Officer has carried out from time to time certain experiments of a more or less crucial character which have come up for solution in the prosecution of this work at the other laboratories. The phenomena associated with the transmission of high-frequency waves over bare wires in earth or water are obscure and complex, and the writer has formulated no definite theory at the present time.

RESULTS OBTAINED.

1. Telephone and telegraph communication has been established between Fort Washington, Maryland, and Fort Hunt, Virginia, across the Potomac River, below the City of Washington, over a distance of about three-quarters of a mile, by the use of a bare No. 12 phosphor bronze wire laid in the water to connect the stations. The transmitter (Fig. 1) consisted of an electron tube oscillator which delivered a current of about 270 milliamperes to the line at a frequency of about 600,000 cycles a second. At the receiving end of the line an electron tube and a six-stage amplifier were used without any earth connection. (*See* Fig. 2.) With this arrangement good tuning was obtained at both ends of the line, and telegraphic and telephonic transmission secured over the bare wires immersed in fresh water.

2. A resonance wave coil (Fig. 3) has been developed. The coil is in the form of a long helix wound with a large number of turns on which stationary waves are produced by the incoming radio signals. An electron tube is used as the detector, the grid being connected to the point of maximum potential on the coil. The wave coil may be used either as a part of the usual antenna system or a part of a line wire, or it may act itself as the antenna for picking up the energy of the signals. In the latter case the coil may be either free at both ends or grounded at one end. Good results have been obtained in either case. It has been also found that the open coil has directional properties and can be used as a goniometer not only for horizontal measurements, but for vertical measurements as well. This form of radio goniometer has the great advantage that it permits not only of determining the plane where the signals are strongest, but also the direction from which such signals proceed.

Telegraph and telephone communication has been also established between two stations at the Signal Corps Research Laboratories at Camp Alfred Vail, Little Silver, New Jersey, using a bare No. 16 copper wire buried in the earth to a depth of about 8 in. to connect the stations. The distance between the two stations was three-quarters of a mile. Frequencies as high as one million cycles a second were used. Similar communication has been carried on over a bare wire one and three-quarter miles long laid on the surface of moist earth. The current at the transmitting station in these installations was about 100 milliamperes. It has been shown that a bare wire buried in moist earth with the distant end open can be tuned both at the transmitting end and at the receiving end.

SUGGESTIONS.

1. In the older art of ocean telegraphy, the elaborateness of line construction has already reached a practical limit. The best Atlantic cable of the present day is limited in operation to electric waves of frequency of the order of magnitude of 10 per second. The electrical construction is such as to limit the voltage employed on any long cable to from 50 to 80. The relative values of the line constants in any ocean cable preclude the possibility of ocean telephony.

The most promising hope of improving the line construction for ocean cables is believed to be, to abandon the present method of design and construction, and to start with the simple case of bare wires in water using high-frequency currents and study the necessary changes to produce optimum transmission.

The use of a high-frequency "carrier" has the inherent advantage that the distortion phenomena accompanying present methods of long distance transmission are eliminated, and we are principally concerned with the problem of reducing attenuation. The most suitable voltage may be employed and present multiplex methods may be utilised. The electron tube is available for both the generation and the reception of the waves.

2. During the last few years an intensive study has been made of the surface conditions of wires necessary to produce the emission of

FIG. 3.—LONG COIL USED AS TERMINAL OF RECEIVING END OF SUBMARINE BARE WIRE.

Standing waves were produced on this by the energy from the transmitter. A wire connected to the brass band shown on the coil was connected to the input grid terminal of the amplifier used as a receiving device.

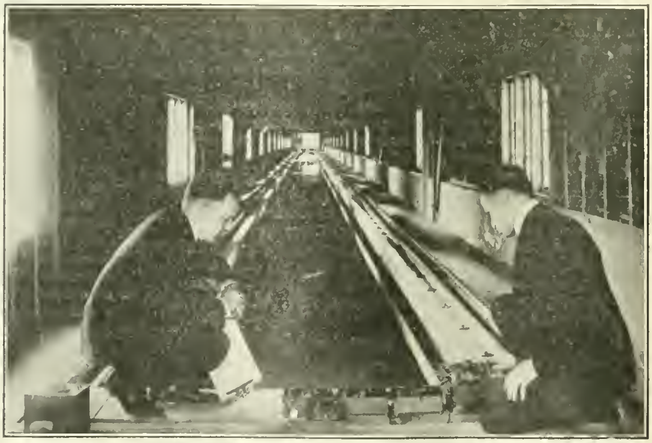

FIG. 4.—INTERIOR WATER TANK LABORATORY, BUREAU OF STANDARDS, WHERE MEASUREMENTS ON SUBMERGED WIRES WERE MADE

electrons, and to this intensive study, both by universities and industrial research laboratories, is due the high state of efficiency of the present electron tube. Nothing short of a similar study of the surface conditions of wires for preventing the emission of electrons instead of producing them, will finally give us the wire conductor of the future.

3. The development of types of resonance wave coils, both open at one end and at both ends, for general radio work, offers an interesting field for investigation. This involves the study of the electron tube as a potentially operated device. The application of such coils properly designed for specific purposes may lead to the practical solution of a number of radio problems such as directional effects, and wave coils antennae of very small dimensions.

4. The account of the experiments thus far conducted, and the reasons which have led to the undertaking of these experiments on the part of the Signal Corps, are presented to the National Academy of Sciences at this time in conformity with the new spirit of organisation for national and international research so admirably typified by the National Research Council which is under the general direction of this official body.

Permanent Magnets in Theory and Practice.*

By S. EVERSHED.

(*Concluded from p.* 618.)

COMPARISON OF PREDETERMINED AND OBSERVED QUANTITIES.

Agreement between predeterminations and practice can only be judged by tests on the completed apparatus, *e.g.*, by verification with a search-coil and ballistic galvanometer, or by induced methods. Recently discrepancies have been reduced within reasonable limits—ultimately about 3 per cent. error. Such differences are due largely to lack of uniformity in the steel. Three typical verifications are shown in the Paper.

AN EXPERIMENTAL PROOF.

In practice one can only ensure approximate identity between test-piece and magnet. To obtain a comparison free from this source of error, an experimental magnet was devised which could act both as the test-piece from which the demagnetisation curve would be obtained, and as a permanent magnet for comparison between forecast and performance. The magnet was of a circular ring of rectangular cross-section. The requirement was the maintenance of a magnetic flux in the air-gap between the parallel end faces of the severed ring. First treating the hardened steel ring as the test-piece, it was wound with magnetising and secondary coils for making the customary ballistic test, the air-gap being eliminated by screwing the tension strap until the end faces were in close contact. The steel was carried through a number of maximum magnetic cycles, and a complete series of observations of flux density and applied magnetomotive force obtained. The demagnetisation curve, shown in Fig. 4, formed the basis for predetermination. Figures were obtained for plotting the derived curve, connecting φ with the ratio β/φ.

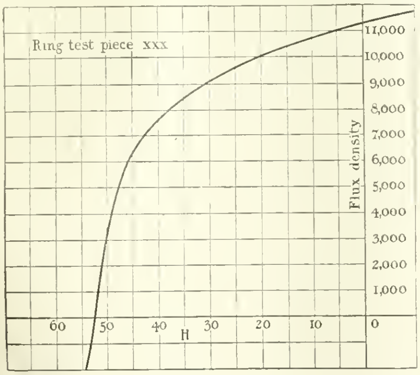

FIG. 4.—DEMAGNETISATION CURVE OBTAINED FROM THE EXPERIMENTAL RING MAGNET AS A TEST-PIECE.

The fully magnetised ring was then investigated as a permanent magnet, complete experimental data being obtained as to flux in the steel, variation of flux density along the length of the magnet, and flux traversing the air-gap, by means of movable search coils. Predetermination was carried out both by the approximate method of the ratio equation and by step-by-step integration. To estimate leakage conductances required careful consideration, and the author was led to the conclusion that between the neutral section and the half-way points q would have some reasonably constant value lying between 1·11 and 1·18. The conductance of the fringe paths in the neighbourhood of the air-gap was considered, by using the formula $q = 2\pi(\varrho \cdot z)$, given in the appendix. Ultimately the author presents a table showing discrepancies ranging from 1·9 to 3·7 for air-gaps up to 0·148 cm., and 7·8 for an air-gap of 0·268 cm. These are favourable examples of forecasts by the ratio equation, the discrepancy more often being over 5 per cent. The large discrepancies for the air-gaps over 0·2 cm. are partly due to error involved in the assumption that the conductance of an air-gap is equal to the ratio area/width.

For a more precise comparison, a forecast was made by the method of integration, taking as an example an air-gap width of 0·148 cm. The author describes this process in detail, and the final results are shown in Figs. 5 and 6. The discrepancies in this case are only of the order of 0·24 to 0·85 per cent.

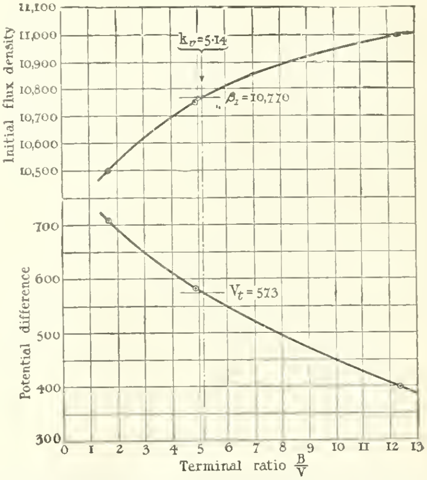

FIG. 5.—PREDETERMINATION OF RING MAGNET. GRAPHS DRAWN ILLUSTRATING THE METHOD USED FOR DETERMINING THE FLUX DENSITY AT THE NEUTRAL SECTION AND THE TERMINAL P.D.

The investigation shows that when errors arising from want of identity between the test sample of steel and the steel of the magnet are entirely eliminated, the accuracy of the method of step-by-step integration is much more than sufficient for purposes of design and forecast.

It is instructive to compare the energy output obtained from a permanent magnet with the maximum amount of energy which the same volume of steel could maintain in external space under the ideal condition of uniform flux density. Comparative figures for the four magnets taken as examples of predetermination are given in the original Paper.

THE CRITERION OF MAGNETIC QUALITY FOR MAGNET STEELS.

It appears that the total possible external energy $\left(\frac{\beta_i \varphi_e}{8\pi} \times \text{volume}\right)$ varies, in the four cases, from 234,100 to 5,240,000 ergs; the proportion of this energy delivered from 28 to 90 per cent. and the proportion utilised from 28 to 77 per cent.

In conclusion, the author discusses the criterion of magnetic quality for magnet steels, arriving at the conclusion that the best criterion of merit is the maximum value of the energy product $\beta\varphi$, which is precisely defined, easily measurable and furnishes the key to economic design.

Figures for $\beta_0\varphi_0 \div 8\pi$, varying from 5,600 to 13,100 for various kinds of steel, the maximum available energy in ergs per cubic centimetre, and for the coercive force *H* (varying from 41 to 68 for steels) are given in the original Paper. For comparison data on iron are also included. The addition of only 0·7 per cent. of carbon to iron immensely increases the surplus magnetomotive force, and the further addition of tungsten brings about another large increase. The recent discovery by Prof. Honda of an iron-cobalt-carbon-chromium steel, stated to have a coercive force of about 200, is a notable advance.

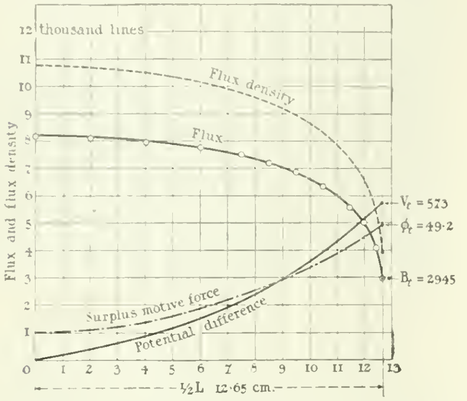

Fig. 6.—Magnet Diagram Predetermined for the Ring Magnet with an Air-gap 0·148 cm. wide. All the Curves are Drawn from the Series of Values Obtained in the Course of Step-by-step Integration; the Centres of the Small Circles are Values of the Flux Obtained Experimentally by Means of a Sliding Search Coil and Ballistic Galvanometer.

Although it has hitherto been natural to use metals which normally possess powerful inherent magnetomotive forces, the choice of material for permanent magnets is not necessarily so restricted. Apparently every atom is potentially magnetic, and future discovery may result in the conversion of a so-called non-magnetic element into a magnetisable substance in which the effective molecular currents will surpass those of iron in their strength (as indicated by the Heusler alloys.)

The appendix of the original Paper contains a very full treatment of the estimation of magnetic conductance, many special formulæ being presented.

DISCUSSION.

Mr. Ll. B. **Atkinson** was sure that Paper would rank with those of Hopkinson and Kapp, in which they gave the magnetic constants in the dynamo. This was the first published attempt to put forward on a basis usable by engineers a system of design and predetermination of permanent magnets. The author had given his physical conception of the mechanism by which the observed results were reached, but they must carefully distinguish between his theory and the results of the predetermination which arose in his mind from that physical conception. The author said the theory of magnetic matter, if used in a purely mathematical sense, could not fail to explain the phenomena—but only provided new laws were frequently introduced to account for the actual facts. It was a matter for congratulation that the author had come down solid for the adoption of the molecular electron current as a basis for permanent magnets. Engineers were not thinking sufficiently in terms of electrons. Quoting from Maxwell, the author said the conception of perfectly conducting circuits led to results exceedingly different from any phenomena observed with ordinary conductors. The author had not sufficiently recognised this point. He said if there were two perfectly conducting circuits at right angles, and these were allowed to move as they would until the currents were in the same direction, the energy would have increased. It would have increased if the currents had been maintained by an external source of E.M.F., but without that, the energy would be less in one direction than the other. The author quoted Langevin in support of the thesis that molecular current was really a constant quantity, but that only related to the possible variation in the molecular current due to the creation of a magnetic force by an exterior current. Changes of relative orientation must necessarily involve great changes of the molecular currents. This would disturb the author's conception, which was based on a constant magneto-motive force per molecule, and the addition and subtraction of those magneto-motive forces in a medium of defined magnetic properties. The flux passing through a perfectly conducting circuit could not be altered. Consequently, in a medium where the molecular currents changed their orientation, the induction threading every molecular circuit was always constant. If a molecular line of induction could shorten by any small change in the orientation the change would take place, and if the result of orientation was to increase the line of induction it would not take place. The opening of the steel ring increased the reluctance between the poles, which diminished the flux in the magnetic circuit. The author favoured the idea that in all circumstances the area of the orbit—*i.e.*, the diameter—was the same, but he (Mr. Atkinson) favoured the idea that the diameter shrank or increased as the case might be.

Prof. E. H. **Crapper** wanted to be able to tell the steel maker what it was they required. Was there a simple easily determined quantity which would serve as a criterion of magnetic requirements? He would like to receive further information about the chrome-cobalt alloy, incidentally mentioned.

Major K. **Edgcumbe** remarked that the author had said predetermination and design must be regarded as two separate sides of the question. When he saw the author's table which showed one could predetermine magnets within one or two per cent., he was a convert to his system at once. In regard to design he was not sure they had not a good deal more to do. Mr. Evershed dealt purely with the question of getting the utmost possible magnetic energy out of a given volume of steel. He worked at the flux density which would give him the maximum "betaphi." Was he satisfied that it would also give him the required permanence? He (Major Edgcumbe) thought that the reluctance was, in most cases, of more importance than the weight and size of the magnet. Two forms of permanence were required; one by the magneto manufacturers, where the magnets were subjected to great racking, owing to armature reaction, and the other by the instrument maker, who was anxious his flux should not fall by more than 1 per cent. To deal merely with the maximum output seemed like problems they got at college referring to grouping batteries to give the maximum voltage. He joined issue with the author in regard to the symbols he used. There were two points of view to be considered: First of all, whether the symbols were useful as they stood. He would have thought β stood for flux density, but it stood for total flux, and he would have thought V was voltage, but the author called it motive force. Why he left in the M he (Major Edgcumbe) did not know. E.M.F. was still well known. With infinite trouble the International Electrotechnical Commission had got agreement to a certain number of symbols, and the Institution had also given its cachet to them, and he thought it a pity that a classic Paper should go out to the world under the ægis of the Institution with a number of symbols which were the exact opposite of those selected by that International Commission. He suggested that before the Paper was published the worst cases should be revised.

Prof. E. W. **Marchant** said much could be learned on atomic structure from a knowledge of the grouping of the electrons giving magnetic effect, and it appeared that the study of the phenomena occurring in permanent magnetic substances might lead in that direction. Was there any relation between the atomic weights of substances and their capacity to produce magnetism?

Mr. H. M. **Dowsett** described at some length various models of the atom which had been devised, referring to those of Nicholson, Lewis and Langmuir, and gave some details of a scheme which he himself had thought out for making the atomic forces clearer. If a very strong magnetic field was applied to a diamagnetic molecule it would react differentially on the rotational speeds of the two atoms, causing differential changes in the vortex speeds, so that a Zeeman effect was produced. Ferro-magnetism was a function of the turning moment which could be exerted on the axis of such a molecule by an extraneous force acting against the inertia of the revolving system, and this, besides not being difficult to calculate, involved a group relationship such as that described by Mr. Evershed.

Mr. E. A. **Watson** said an important point was the shape of the **BH** loop. It was possible to have magnets with the same magnetic force, and yet having loops of a very different shape, and therefore giving a different quantity for betaphi. It would be very advantageous to define a magnetic condition in terms of three definite numbers. Prof. Kennelly pointed out that for a piece of soft iron $\frac{\mathbf{H}}{\mathbf{B}} = A + \mathbf{BH}$. By plotting **B** against **H** a linear relation was obtained. He then drew a diagram in which the curve of coercive force cut the ordinary **BH** loop at the point of maximum betaphi. The maximum $\beta\varphi$ could be obtained correctly where one had the **BH** curve.

Mr. A. P. **Young** said that the theory of the current ring was alluring, and seemed to have been developed in a logical way. It was assumed that the current rings were free to move as a moving coil was free to move in an instrument. Apparently they must exist in all grades of matter. If magnetic materials were combined in the proportion of three parts of iron and one of nickel, the resulting alloy was non-magnetic. That 25 per cent. nickel alloy was very remarkable. It was often found the forgings, though of correct chemical composition, exhibited magnetic properties if they were heated to 3,000°C., and if allowed to cool they became non-magnetic again. To determine the magnetic flux within 3 per cent. was an achievement, when one considered the error there must have been in the original determination of the **BH** curve. Permanence was a very important factor. But was the coercive force, taken by itself, the true criterion? It was doubtful whether a high coercive force would ensure permanence in the case of a magneto where the magnet was subject to wide variations of temperature and much vibration. There must be some other factor to be taken into consideration.

Dr. E. H. Rayner said if it were assumed, and it was, of course, a large assumption, that electronic number distribution determined atomic properties, including magnetism, then it would appear that atomic weight, which was associated with electronic number, must govern such things as magnetic properties, and magnetic properties must be the result of something dependent upon number and probably upon a peculiar symmetry associated with number.

Col. R. E. Crompton complained that the author had started a new lot of symbols. The Paper, however, was one to be proud of.

The Author said he thought the best word was said by Mr. Young, who remarked that the Paper was going to stimulate thought. That was precisely his object in writing it. There was a fallacy in the experiment by S. P. Thompson (referred to by Mr. Atkinson). If when the ring was pulled open, expanding the gap, a coil were put round the neutral section, the gap might be opened a long way without any change in the flux density of the neutral section being observed. That was because the curve of P.D. underwent an entire change. Unless the experiment were carried out with extreme precision the very minute change that would take place in the flux in the neutral section would be unnoticed. He had been using his symbols long before there was an I.E.C. He was perfectly willing to use their symbols if they meant what he meant

Correspondence.

COMMERCIALISM v. TECHNOLOGY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In a note headed "Commercialism v. Technology," which appeared in The Electrician of May 28, reference is made to the interests which have established the science of wireless telegraphy on a sound financial basis and regret is expressed that "This same business consolidation has tended to a corresponding lack of enterprise on the technical side." After remarking that "there is great secrecy about these matters," the note referred to goes on to say that as far as can be ascertained "progress on the technical side of wireless telegraphy in this country has not been so great as it probably would have been had conditions been different." You find it most regrettable that a young science should be handicapped in this way, and look for a determination to push forward rather than to rest on past achievements.

The science of wireless telegraphy was established on a sound financial basis by G. Marconi and the companies bearing his name, hence it is clear that your remarks refer to ourselves and we may perhaps be permitted to comment upon them.

That there has been a great deal of secrecy regarding technical developments in wireless during the last six years is due to the recent war. That there is a certain amount of secrecy now, so far as we are concerned, is due to the fact that early publication would adversely affect our position in regard to patent rights in certain countries. Sufficient, however, has been published to indicate that, contrary to your suggestion, very considerable progress has been made and that the vast sums spent by us year by year upon technical research have not been without satisfactory result.

Take the case of wireless telephony. In 1913 we manufactured a small set of 1/10-kw. rating in which the valve was used as an oscillation generator. This year we are in a position to supply standard sets up to 6 kw., have given a highly successful series of demonstrations with a 15-kw. valve set, and have in hand tests with a 100-kw. 'phone of similar type. That we have not yet obtained even larger outputs must be attributed to the fact that during the war the energies of our engineers were necessarily devoted to the production of low power sets for naval and military purposes and for use in aircraft.

Another example of technical progress will be found in the wireless direction finder. This has been improved beyond recognition, and in its present form is a simple and reliable piece of apparatus, which indicates the "sense" as well as the direction. Our standard pattern for ships has a wave-length range of 300 to 5,000 metres, and will pick up the ordinary low power coast stations at distances of 300 to 400 miles. The magnitude of the technical difficulties which have been overcome here will be appreciated by those familiar with the subject.

We could multiply instances, but will mention only one other development which has been the result of prolonged experiment. We refer to the so-called "wireless beam," by means of which signals or speech may be projected definitely in a given direction much as light is projected by a searchlight. This is an example of recent technical progress along lines well off the beaten track, and is a practical application of the knowledge gained by our experts in research work on very short waves.

Your readers may rest assured that we have no intention of "resting on past achievements," but that we are fully alive to the possibilities of technical research and the necessity for progress, and shall continue to apply our energies and resources in this direction.

We may add that we have the advantage of close technical intercourse with the leading wireless companies of the world, and reap the benefits of their researches as well as our own. In our opinion such an arrangement makes for progress, and we regard it as an important advantage resulting from the "grouping of interests" upon which you comment unfavourably.—I am, &c.

Godfrey C. Isaacs.

[We are glad to have Mr. Isaacs' able exposition of the recent progress made by the Marconi Company and to learn that satisfactory results are being obtained from the "vast sums" that have been spent upon research by that organisation. While admitting that for patent reasons delayed publication of new developments may sometimes be necessary, we still consider the mist which too often surrounds what is going on in the wireless world is not in the best interests of the science. The Marconi Company are developing along certain fixed lines and, being a commercial concern, the researches which they undertake must be largely controlled by those lines, so that there is a consequent limitation of their field of investigation. This is inevitable and no blame can attach to them for this. None the less it is regrettable from the point of view of the science of wireless as a whole and perhaps also a little from the point of view of the Marconi Company themselves. For real development no point, however theoretical or however remote from present day practice, must be left uninvestigated, no method however different from those at present in use must be left untried, and a ruthless scrapping of old ideas and apparatus must be manfully adopted when necessary. Is this being done?—Ed. *E.*]

MERCURY ARC RECTIFIERS FOR LARGE OUTPUTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The article "Mercury Arc Rectifiers for Large Outputs" appearing in your issue of January 2, 1920, contains the following statement on page 11: "The favourable results obtainable with apparatus of low output encouraged the Société anonyme Brown, Boveri & Company to investigate the question of building rectifiers for large outputs. A rectifier company was formed by the firm in 1912 in Glaris (Switzerland) for the purpose of carrying out the necessary experimental work and the technical staff of this company soon made the acquaintance of numerous difficulties of a practical nature."

The writer may be permitted to point out that this statement is not correct. The Brown-Boveri rectifier was not developed by the firm mentioned nor by the rectifier company in Glaris (Switzerland), but by the firm Hartmann & Braun, located at Frankfurt (Germany), where the large capacity rectifier was developed on the Schaefer system. (Compare "Elektrotechnische Zeitschrift," p. 2, 1911.) In 1913 Brown-Boveri took over the patents of Hartmann & Braun, respectively, and Schaefer and the technical staff responsible for this design entered the firm of Brown-Boveri in Baden (Switzerland) as directors. It may also be stated that it was the writer who first took up rectifier work in Switzerland by making an extensive experimental and theoretical investigation[*] on the mercury arc rectifier (Cooper Hewitt rectifier). Incidentally the writer invented a basic principle[†] especially adapted to mercury arc rectifiers of very large capacity (compare "Schweizerische Bauzeitung," No. 13, 1920, p. 147). As the original Cooper-Hewitt patent still controlled the Brown-Boveri or Hartmann-Braun Schaefer patents this firm was dependent on the Cooper-Hewitt or the Westinghouse interests.

The article, "Mercury Arc Rectifiers for Large Outputs," also contains the following statement: "The losses in the mercury arc rectifier are equal to the product of the current and the pressure drop across the arc, &c. The losses, therefore, for a given working pressure, are equal to the load current multiplied by a constant, this constant being the voltage drop across the arc, so that the efficiency of the rectifier is the same for all values by all loads."

The writer, having made extensive investigations on this subject,[‡] can only state that this statement is clearly erroneous. In the articles quoted, the writer has clearly shown how all the losses in a rectifier can be determined and it would be highly desirable that such unreliable statements as mentioned above should disappear from the technical literature.—I am, &c.,

Yonkers, N.Y., U.S.A. Wm. Tschudy.
May 4, 1920.

THE ENGLISH DOCTOR OF PHILOSOPHY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: If my article on this subject in your issue of May 28 has given rise to misconception of my views upon the teaching profession, it is, I fear, due to a somewhat apprehensive but quite illegitimate inference from what I have said to what presumably I might have said, but did not say and neither would nor could have said with good purpose or any deliberate intention.

I fully appreciate the fact that many teachers are much overworked, to the discredit of those who might ameliorate their lot. But teachers generally are not so taxed, particularly in the higher grades of their profession; and I have little doubt but that the path of least resistance is no unimportant factor in deciding their choice.

Mr. Paley Yorke has, I think, quite misunderstood my meaning; which was that many young men at the universities, after a course of research and with the hope of pursuing it, take up teaching as a profession, as the readiest means to subsistence and the least risky in its consequences. This is mainly due to the natural tendency to follow the path of least resistance; a truth which I venture to think few acquainted with the facts would endeavour to dispute.

One must not, however, confuse the characteristics which may induce many to choose teaching as a profession with the actual realities that, as Mr. Yorke points out, may so often disillusion their youthful propensities, but add so much to the worth and dignity of their profession.

My remarks, indeed, as to the popularity of the didactic art are evidenced by the figures quoted from the Report of the Consultative Committee of the Board of Education and clearly indicate that a dearth of teachers must mean a dearth of scientific workers all round; but that teachers being in the overwhelming majority amongst research students, their numbers could be increased only by depleting the other ranks of science, and diverting still further the attention of such students from those other paths in which their services may be needed with even greater emphasis.—I am, &c.

London, June 4. J. Butler Burke.

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[*] "Experimentelle Untersuchungen am Quechsilberdampf Gleichrichter für Wechselstrom," Thesis, Federal Technical University, Zürich, 1912.

"Bulletin" des Schweizerischen Elektrotechnischen Vereins, 1912. Über die Enwicklungs Möglichkeiten des Quechsilberdampf Gleichrichters auf Grund experimentelle Untersuchungen. Zeitschrift für Elektrische Kraftbetriebe und Bahnen, 1913.

[†] German patent No. 255,547; American patent No. 1,189,887; re-issue, No. 14,816.

[‡] See above mentioned articles; "Electrical World," 1916; "Elektrotechnische Zeitschrift, "1917; "Electrical World," 1918; Schweizerische Bauzeitung, 1920, p. 147.

The Thermionic Valve in Wireless Telegraphy and Telephony.

In introducing his discourse of this title, delivered at the Royal Institution on May 21, Prof. J. A. Fleming, F.R.S., drew attention to the fact that the emission of negative electricity from hot bodies had been studied for 25 years before the first application of this emission had occurred to himself in 1904. In 1883 Edison observed that a current flowed in a glow lamp between a hot filament and a metal plate near or around it; W. H. Preece, he himself, Hittorf and others studied the Edison effect; J. J. Thomson demonstrated the corpuscular character of negative electricity, but the Fleming valve-rectifier dated from 1904, when an ardent search was being made for detectors of radio-telegraphic waves. The two-electrode valve and the three-electrode valve of Lee de Forest, 1907, gradually replaced the coherer, the magnetic-wire detector and the electrolytic detector, and later on became most valuable also as current amplifiers and as oscillators. Prof. Fleming explained and demonstrated these applications by many striking experiments, and further demonstrations were given in the other rooms, before and after the discourse, by the Marconi Company and the General Post Office.

In wireless telephony the thermionic valve, with its plate and grid circuits inductively coupled, sets up persistent oscillations in the plate circuit, which are transferred to a properly-tuned aerial; the high-frequency currents flowing up and down the aerial—modulated by the operating microphone and a control valve, the grid of which is inductively coupled with the transmitter and its battery—produce magnetic and electric effects in the surrounding space, and the waves propagated impinge upon the receiving aerial and produce feeble alternating currents, which are amplified and rectified by valves in cascade and sent through a telephone.

Last year the Marconi Company experimented between County Kerry and Cape Breton, for 12 days between 10 a.m. and 1 p.m. G.M.T. on the minimum power required for transmitting speech across the 1,800 miles of the Atlantic Ocean. It resulted that the 2·5 kw. alternator used might for regular service profitably be replaced by half a dozen generator valves.

Dr. Fleming described his four-anode valve for a radio-telephony bell call. Such a bell must not be put in action by every passing signal, and to prevent that the bell relay is given sufficient motion to respond only to series of very long dashes or to trains of electric waves: the Marconi Company sends these dots at the rate of 180 per minute, and the relay contacts are further improved by passing feeble electric oscillations across the platinum-carbon contacts (Fleming's patent). In the Fleming four-anode valve, the tungsten filament is surrounded by four curved metal plates coupled in two pairs. The first pair, the collecting plates, are joined to the filament battery and the relay; the electrons coming from the filament are deflected and prevented from reaching the collectors, when the potential plates (second pair) are charged; these are connected through a resistance of 15,000 ohms or more to the plate circuit of a three-electrode valve. When, however, the grid of this latter valve receives even a small negative potential (from the oscillations in the aerial), the relay contact will be closed. With respect to beat reception, Dr. Fleming mentioned Captain H. J. Round's methods for using the same thermionic valve for generating the beats and for detecting them at the same time.

His concluding remarks concerned the importance of valves as repeaters on ordinary telephone lines.[*] When New York and San Francisco were to be put in telephone connection by a line 3,400 miles in length, it was found that even with a lavish expenditure of copper articulation became bad beyond Denver. The interposition of valve-repeaters admits of economising copper, and the line was built in four sections with repeaters at three stations. A transformer is inserted on one side of the line and the primary terminals joined to the grid and filament of a valve, the plate circuit of which contains a battery and another transformer, the secondary of the latter being connected to the continuation of the wire. Special arrangements are needed because a telephone line has to be used in both directions, and care has to be taken lest the plate current of the valve, reacting on its own grid, set up a howling in the receiving telephone. The simple arrangement which Edison had devised for this purpose, Dr. Fleming said, could only be used when the valve was placed exactly in the electrical centre of the line, whilst the thermionic repeater of the engineering department of the General Post Office balanced each section of the line against an artificial line; two valves were required, one for talking in each direction. These valve relays outclassed all other powers of microphonic relays, and if the British trunk telephone systems were to be relayed, much copper would be economised by a widespread use of the thermionic valve.

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[*] *See* The Electrician, Vol. LXXXIV., pp. 517 543, 571, 618, May 7, 14, 21, and June 4, 1920.

Some Recent Armoured Switchgear.

One of the recent colonial converts to the principle of armourclad switchgear for sub-stations is the Electricity Department of the Cape Town Corporation. Fig. 1 shows the back view of switchgear of this type, which is intended eventually for the Mowbray-street sub-station.

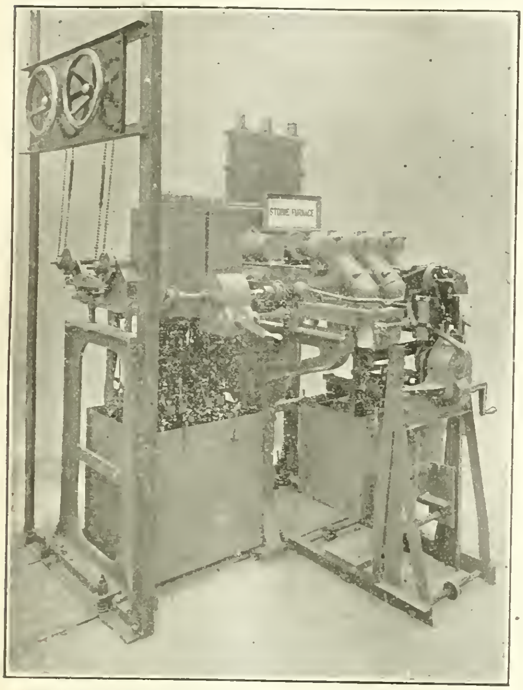

Fig. I—Back View of Reyrolle for Cape Town.

The 'bus bars are divided into two sections—one transformer and three feeders on one section and one transformer and two feeders on the other. The protection for each type of panel is plain overload with fuse-time limit overload relays.

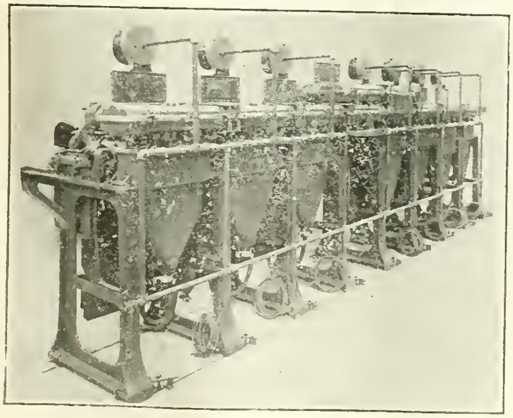

Fig. 2.—Switchgear for Electric Furnace Work.

The photograph shows the gear assembled at Messrs. Reyrolle's Hebburn works, and in order to facilitate erection in Cape Town the several parts were numbered.

This gear is being installed to replace some existing gear of the cell type, the alteration having become necessary owing to the need for increasing the number of panels, and there not being sufficient space available to carry out the extensions on the existing gear. The compactness of the gear and complete enclosure of all conductors, including secondary wiring and tubings, are clearly illustrated in these photographs. This is an instance which shows the adaptability of the gear, which can be moved from place to place without involving serious building alterations and prolonged erection work. In this instance this is essential, as building costs are an even more important consideration in the colonies than at home.

The V.I.R. cable is used for instrument and trip coil connections, and is differently coloured and marked to identify its use. When connected up its whole length will be enclosed in a system of metallic tubing. The switch tank can be conveniently lowered on to a portable truck when the switch is in the "drawn out" position. The entire operation, lowering of the switch tank and inspection of the contacts, is only a one-man job. All conductors are completely enclosed, thus reducing to a minimum shock and fire risks.

Fig. 2 shows one of Reyrolle's standard 6,000-volt draw-out switchgear panels combined with an oil-break change-over furnace switch. The change-over switch is shown to the right, and may be arranged with any number of ways to suit the various tappings or connections required for furnace transformer switchgear.

The tank, change-over switch and the main automatic oil switch are interlocked so as to prevent erroneous operation, and to make it impossible to expose the conductors until these have been isolated from the system. This gear is arranged to operate from a distance by chain drive.

Squirrel Cage Motors.

There are difficulties to overcome in the manufacture of the squirrel cage type of machine, one of which is important, namely, the method of connecting the rotor bars to the rotor rings. There are many patents relating to the construction of squirrel cage motors. Messrs. Higgs Brothers, of Birmingham, have recently patented a bar winding particularly applicable to squirrel cage rotors, constructed as follows:—

Drawn copper of suitable rectangular section is used. Before this is inserted in the rotor one end of the bar is twisted at right angles to itself and then inserted in the rotor core, as shown in the first illustration.

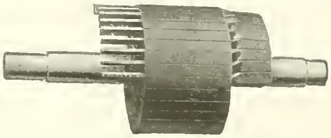

Fig. 1.—View of Rotor Bars in Position Before Ends are Bent Over.

The rotor is designed so that these bars, when inserted, practically touch one another at the ends. When all the bars are assembled the other end of the bar is also bent at right angles, then the ends are welded between the joints. The finished rotor is shown in the second illustration.

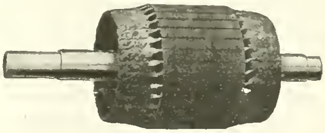

Fig. 2.—The Finished Rotor.

The advantages of the rotor constructed by this method are obvious. The usual rotor and rings are entirely dispensed with; the extension of the bar itself forms the ring. No flux or brazing compound is used in making the joint, only pure electrolytic copper throughout. They are preferably welded with oxygen-acetylene apparatus, and when this is done, the ends of the bar are a continuous ring. It is a sound mechanical job and there is not the usual fear of nuts, bolts and screws coming loose, nor, for instance, when the rotors are constructed and the end rings cast on, is there the chance of poor joints. Messrs. Higgs Brothers have a large number of these rotors in use and they state that in no single instance has a complaint been received regarding them, nor has trouble occurred in the process of manufacture or in their own test.

The exhibition, which was recently opened at the British Institute of Industrial Art (217, Knightsbridge, London), will be open for four months The exhibits include high-class specimens of furniture, porcelain, silver and other manufactures: but the electrical exhibits are limited to a few stand and table lamps incidental to displays of furniture. The Institute has been established by the Board of Trade and the Board of Education, with the object of encouraging quality of designs, workmanship and material in industry generally. It is intended to hold subsequent exhibitions at other places. Sir H. Llewellyn Smith, G.C.B., is chairman of the Board of Governors; Major A. A. Longden, D.S.O., is appointed director; Mr. T. L. Horabin, secretary; and Mr. W. B. Macdougall, technical officer.

Legal Intelligence.

A Patent Exploitation Agreement.

Mr. Justice Greer recently heard an action relating to the exploitation of electrodes for secondary batteries (No. 120,671 of 1914/1915). The plaintiff was Mr. H. E. Gluck, who claimed damages from Mr. S. Willner and Mr. A. Connell for alleged breach of contract.

Plaintiff's case was that in February, 1916, Willner requested him to assist defendants with the necessary finance for commercially exploiting the patent. It was alleged that Willner stated to plaintiff that he was the owner of the patent, that he had sold the German and American rights, that he wanted to exploit the English, Colonial and other foreign rights, and that the patent was held in trust for him by Connell. In May, 1916, it was verbally agreed that plaintiff should provide the necessary money and should take offices and register or obtain control of a company with limited liability and that in consideration plaintiff should have, in addition to payment of the money advanced and expenses incurred by him, one-third share of the English and Colonial rights or one third of the profits from the sale of the patent. Willner was to act as secretary of the company. Certain personal loans were made by plaintiff to Willner, who undertook not to dispose of his rights unless with plaintiff's consent. In May, 1917, Connell assigned the patent to a gentleman, who afterwards assigned them to the Apex Electric Accumulator Syndicate, Ltd.

The defendant Willner denied that he was interested in the patent as owner or partner or joint owner with his co-defendant, Connell, or that he acted, or had authority to act, as principal or agent as alleged. It was also pleaded that in January, 1916, Willner introduced plaintiff to defendant Connell as a person willing to provide the capital required, but plaintiff failed to do so, and that in August, 1916, Willner informed him that Connell would dispose of the patent. Willner also denied the alleged agreement, but admitted that plaintiff lent him sums amounting to £71, which he had repaid. The defendant, Connell, denied that there was any agreement between him and plaintiff.

After plaintiff had given evidence, the defendant Willner said that he was the patentee in Germany of the invention, which was brought to England. When the patent was made over to Connell, witness expected to get some benefit out of it.

The defendant Connell said that the English patent was transferred to him. Mr. Willner, who had got into difficult financial circumstances, asked him to take over the English patent as a recompense for what witness had done for him, but Willner would not part with the world rights. He told Willner that if he could get somebody to exploit the patent and it realised something satisfactory, he would not forget him.

In giving judgment, his Lordship said he doubted whether any of the witnesses could be trusted to remember exactly what happened four years ago, and if plaintiff's evidence had rested entirely on his own recollection and had been set against the evidence of defendants he should have found himself unable to act upon his testimony. Mr. Willner's evidence satisfied him that he knew Mr. Gluck was undertaking liabilities and meeting expenses in consideration of a promise made to him. He thought the most that took place was that Mr. Connell was willing that Mr. Willner should negotiate and see what could be done, but he was not pledging himself to anything until a financial proposition was brought before him which he could consider, and therefore Mr. Connell was entitled to judgment. The breach of contract was due to what Mr. Willner did. The damages were difficult to estimate, but he had decided to give Mr. Gluck against Mr. Willner £100 beyond the £94, which plaintiff had expended.

Parliamentary Intelligence.

The Royal Assent has been given to the following Acts of Parliament:—Public Utility Companies (Capital Issues), Tramways (Temporary Increase of Charges) and South Wales Electrical Power Distribution Companies' Acts.

On Tuesday the Edinburgh Boundaries Extension and Tramways Bill, which (*inter alia*) seeks to extend the boundaries of the Corporation so as to include Leith and other adjoining districts, was read a second time in the House of Commons. The Bill has been passed by the House of Lords.

Private Bill Committees have resumed consideration of the remaining private Bills of the Session. The Sheffield Corporation Bill, which authorises various tramway extensions and the provision of omnibus services, &c., has been passed by the Local Legislation Committee of the House of Commons. The West Riding and Derbyshire County Councils opposed the omnibus clauses as they desired a modification of the existing arrangement, which allows ¾d. a mile for road maintenance, and after hearing the parties the Committee decided to leave the question of road maintenance, &c., to the Ministry of Transport.

The Local Legislation Committee of the House of Commons (presided over by Sir Harry Samuel) has approved the Bill promoted by the North Metropolitan Electric Power Supply Company, which confers further financial and other powers upon the company. It was stated that in 1904 the company sold 1,800,000 units, but to-day they sold roughly five or six times as much. The most important industrial districts had been supplied, but there remained certain residential districts, and there was the prospect that very large supplies of electricity would be required for the electrification of the suburban lines of the six railways running through the district.

Commercial Topics.

A Committee on Canals.

A committee, of which Mr. Neville Chamberlain, M.P., is chairman, has been appointed by the Ministry of Transport to consider and report as to what portion (if any) of the inland waterway system of the country should be acquired by the Ministry with a view to improvement, and upon what terms; and also what improvement should be carried out in such acquired portions, &c. It is time steps were taken to improve the canals of the country, and we hope that the committee will also consider the question of the adoption of electric traction.

* * * *

Electric Furnace Progress in U.S.A.

Approximately 300,000,000 units of electrical energy were used during 1918 in producing steel from electric furnaces. In addition, large blocks of power were used in the production of ferro-alloys, carbide and similar products, and the total amount was greatly increased during 1919 by the addition of 36 electric furnaces in the steel industry, so that the total number is 323, against 287 on Jan. 1, 1919. These figures are taken from the report of the Electric Steel Furnace Division of the Commercial Section of the National Electric Light Association at the recent convention in Pasadena, Cal. The trend seems to be toward the adoption of large furnaces, the economic factor being sufficient to attract the larger plants in the industry.

* * * *

German Electrical Developments.

Some of the big German electrical manufacturing companies have recently made large increases of capital and entered into arrangements for obtaining foreign capital. In this way it is hoped to obtain supplies of raw materials and to secure foreign markets for some of their manufactures. We have already referred to the amalgamation of the A.E.G. and the Felten & Guilleaume Carlswerke A.G., and to the increase of the former company's capital from 100,000,000 to 300,000,000 marks, after an issue of 100,000,000 marks in bonds. It is now announced that an American banking syndicate (Kuhn, Loeb & Company and Guggenheim & Company) will take 25,000,000 marks of new shares in the A.E.G., but to ensure continued German control the whole of these new shares are to be held by one person, and they will be administered by a committee of three—two to be appointed by the A.E.G. and one by the American syndicate. Moreover, the shares can only be sold through the A.E.G.

The capital of 60,000,000 marks of the Felten & Guilleaume Company is to be doubled, and the new shares will be acquired by a Luxemburg syndicate (Burbach-Eich-Düdelingen), which will cover Felten & Guilleaume's requirements in steel and semi-manufactured articles.

The Siemens & Halske Company intends to raise its capital from 63 to 126 million marks, and to issue 20 million marks in bonds. The company proposes to protect itself from foreign control by granting to a small group of shares (the owner of shares Nos. 1 to 9,500) a thirty-fold vote. It is, however, proposed to make the acceptance and, later, the transference of these preference shares dependent upon the sanction of the President of the Berlin Chamber of Commerce. The Bergmann Elektricitäts Werke A.G. also propose to make an increase of capital from 28 to 80 million marks and to make an issue of 20 million in bonds.

These interesting developments indicate a desire on the part of the leading German electrical manufacturers to reorganise themselves, and they deserve careful attention by British manufacturers and engineers.

* * * *

Atmospheric Nitrogen.

It is satisfactory to learn that steps are being taken to render this country independent of foreign nitrate supplies for explosive purposes. The Synthetic Ammonia & Nitrates, Ltd., has been formed by Messrs. Brunner, Mond & Company, with a capital of £5,000,000 to take over from the Government the manufacture of nitrogen products from air and to develop the business on a commercial scale. Steps had been taken to erect a plant to work a modified Haber process at Billingham (Durham), but work was suspended at the armistice, and the site has been acquired by the new company. A number of chemists and engineers have been retained, and the Government have placed at the disposal of the company all enemy patents bearing on the process on a royalty basis. It is proposed to erect immediately a plant for the manufacture of 100 tons of 100 per cent. ammonia per day, with provision for a rapid extension to 300 tons per day, equal to 150,000 rising to 450,000 tons of sulphate per annum. Arrangements have been made with Explosives Trades, Ltd., by which they undertake to take their requirements of ammonia from the company, and to erect plant to the extent desired by the Government for the oxidation of this ammonia to form nitric acid and explosives derived therefrom.

The question of producing atmospheric nitrogen is also receiving a good deal of attention in the United States where a Bill was recently under consideration by a Committee of the Senate. It is proposed to establish two large plants—one at Sheffield and the other at Muscle Shoals, both in Alabama, which will work in conjunction with the Fixed Nitrogen Research Laboratory at Washington and the Warrior River Station of the Alabama Power Company, and generally to consolidate the manufacture of nitrogen products in the atmosphere in the United States. The product will be primarily employed for military purposes, and, secondly, applied to agricultural uses. The financial arrangements are somewhat curious. Capital will be raised from the Government, and all the dividends obtained by the company will be paid into the treasury of the United States as miscellaneous receipts, due provision being made for organisation, operation and development and the creation of a reserve fund for $2,500,000. The capital of $12,500,000 will be in the form of preferred stock, and will be entitled to a 5 per cent. dividend.

Electricity Supply.

We regret to learn that NEWPORT (MON.) Corporation has decided to place an order for electrical plant with the A.E.G., of Berlin.

Application has been made by BELFAST Corporation for sanction to borrow another £50,000 for the electric supply undertaking.

DARLINGTON Corporation has applied to the Electricity Commissioners for sanction to a loan of £104,000 for additional generating plant and extensions of buildings.

The standing joint committee of the Glamorgan Quarter Sessions and County Council have decided to adopt ELECTRIC LIGHTING at five POLICE STATIONS in the county.

The Corporations of Burnley, Colne, Nelson, Accrington and Rawtenstall have formed a district committee to deal with all matters arising from the formation of a JOINT ELECTRICITY AUTHORITY for the area.

WIGAN Corporation are to be congratulated on the success of their electricity undertaking. On last year's working there was a profit of £13,071, though the price is only 9½ per cent. more now than in 1914.

DARTFORD Urban Council has applied for a loan of £14,928 for a boiler, duplicate bus-bars, mains extensions, and a rotary convertor. A main is to be laid to the works of Messrs. Burroughs, Wellcome & Co., the Monazite Products, Ltd.

Poplar (London) Electricity Committee is to lay electric supply main in two additional streets, and to convert four gas lamps to electric lighting. At the last meeting it was reported that there were 216 new consumers and 169 additions to existing installations.

On the advice of the borough electrical engineer (Mr. W. J. Wood), BOLTON Electricity Committee has increased the charge for electric current for both lighting and power by a tenth of a penny per unit. The request of the Chamber of Trade for a preferential rate was refused.

The Association of LANCASHIRE & CHESHIRE ELECTRICITY UNDERTAKINGS has appointed a Committee to consider the provisions of the Electricity Supply Bill of 1920. A District Joint Board has also been established to settle questions in regard to wages and conditions of service of the staffs.

BARNSTAPLE Council has adopted Mr. J. S. Highfield's scheme for the extension of the electricity works at a cost of £39,000. Apart from this £3,500 is to be borrowed for an additional boiler, draught fan and pump and £1,200 for a feeder cable. It is proposed to charge a flat rate of 10d. per unit. for private and public lighting, and a sliding scale, varying from 8d. to 3d. for power.

It is considered that there is sufficient water-power available in the Dolgoch Ravine to generate electrical energy for TOWYN and ABERDOVEY and for MACHYNLLETH. As the Urban Council of the latter district is disinclined to co-operate in a joint scheme a public meeting has been called at Towyn to consider the situation. It is probable that a local company will be formed for establishing hydro-electric works.

HAMMERSMITH (London) Borough Council proposes to expend £22,000 in laying electric supply mains to the Council's new housing estate, and £5,000 on service mains. 73 street lamps are to be converted from gas to electric lighting at a cost of £755. The change will save £112 per annum.

Acting on the advice of the borough electrical engineer (Mr. G. G. Bell) it has been decided to give a supply of electricity to all the houses to be erected on the Council's new estates through prepayment meters. One service will supply two houses and the estimated revenue is 1s. 6d. per house per week.

The decontrol of coal for domestic purposes came into operation on Monday with the suspension of the HOUSEHOLD FUEL AND LIGHTING ORDER. The maximum price at the pit-head will, however, be fixed under the Price of Coal (Limitation) Act of 1915. The duties of the Coalmines Department and its divisional offices will now be undertaken by the District Coal and Coke Supplies Committees and by a Central Committee. It is to be hoped that as a result of the change electric supply undertakings and industrial users will be able to get a better class of fuel than they have had to use for some time past.

It is gratifying to learn that the unfortunate dispute between WIMBLEDON Corporation and the E.P.E.A. as to the bonus of £30 granted by the National Joint Board to the technical staffs of electricity supply undertakings has now been settled. The Council rescinded on the 4th inst. the previous resolution not to pay the bonus. This satisfactory termination of the dispute is due in no small measure to the persistent interest of the Electric Lighting Committee and its Chairman (Councillor Hatherly-Mynott) in the staff of the Department, and the energetic measures taken by the Mayor (Ald. D. Stuart) to deal with the situation. The influence of the National Joint Board, through its constituent Associations, was also a contributory factor to the settlement.

At last week's meeting of SHOREDITCH (London) Borough Council a new scale of charges for electric current was approved, the present rates of 55 and 65 per cent. over pre-war charges for lighting and power respectively, not being considered sufficient to meet during the current year the increased cost of coal, wages, &c. For lighting the charge is to be 8d. per unit for 1½ hours' m.d., or a flat rate of 6½d.; theatres, &c., 6d.; outside arcs and signs, 4d.; heating, 1½d.; power, 30s. per H.P. of m.d. per quarter, plus 1½d. per unit; trade and testing purposes, 4d.; power discount scale, 2·25d., with discounts varying from 2½ to 10 per cent. for consumption of over 2,500 units per quarter; factory lighting varying from 4d. to 5·5d., where lighting consumption is equal to 5 per cent. of the power demand.

The employees of the City of BIRMINGHAM Electric Supply Department have subscribed for and erected a handsome memorial to their colleagues who lost their lives in the war. The memorial takes the form of a bronze tablet of artistic production, beautiful in design and execution, which has been placed in the entrance hall to the offices in Dale End. It is surmounted by the City Arms, worked in enamel, and bears a suitable inscription on its centre panel. Two side panels give a record of the names of the 31 employees who made the supreme sacrifice. On Saturday afternoon, in the presence of a company representative of all sections of the Department, the memorial tablet was unveiled by Mr. R. A. Chattock, the City Electrical Engineer. The ceremony was a simple one, though not unmingled with touches of emotion. After the unveiling a few words from Mr. Councillor Beale, Chairman of the Electric Supply Committee, and Mr. Jemings, Secretary, brought the proceedings to a close. Photographic copies of the memorial are to be sent to the relatives of the men whose names it bears.

The accounts of the BIRMINGHAM ELECTRICITY DEPT. for the year ended March 31, submitted to the Council on Tuesday, show revenue £1,068,825 (compared with £952,912 in previous year), and expenditure £776,290 (£682,751), leaving a gross profit of £292,535 (£270,161). After providing for interest, redemption of debt, &c., and placing £10,000 (£19,582) to reserve and £50,000 (£50,000) to renewals and special expenditure account. the surplus for the year is £15,323 (£20,008). Units sold were 127,938,924 (140,938,720). Lamp connections are equivalent to 374,624 (352,056) 60 watt lamps, and motors connected aggregate 145,577 (137,405) H.P.

The Electric Supply Committee reported that the sales of electrical energy decreased by about 13 million units, but increased progressively during the latter half of the year. The charges to consumers of l.t. supplies have been increased by about ½d. to ¼d. per unit, according to the class of supply. For lighting (ordinary rates) the charges will vary from 6½d. to 4½d. (for 20,000 units and upwards per quarter); long-hour rates, 5d. and 4d. per unit; restricted hour supply, 4½d. (10,000 units and upwards); factory rate, 5½d.; prepayment meter rate, 6½d.; two-rate consumers, 8d. and 4d.; power, heating and cooking, 3d. and 2⅔d.

SHEFFIELD City Council has applied for sanction to borrow £250,000 for the extension of the electric supply mains, £120,000 for sub-stations and transformers and £30,000 for house services.

In regard to the proposed contract with the Low Temperature Carbonisation Co., the General Manager (Mr. S. E. Fedden) reports that the company undertake to generate steam on three boilers, at Blackburn Meadows power station, by either gas or oil at the same cost as coal-firing. The Corporation are to pay, in addition, 6 per cent. on the cost of fitting the boilers and supplying and erecting an oil tank, &c. This represents £300 per annum. The company will indemnify the Corporation if for any reason gas cannot be supplied or if the scheme is unsuccessful. If the scheme is successful a considerable saving will be effected, as one man can easily take charge of the three boilers. The greatest economy will, however, result in the absence of ash and clinker with its high removal costs. At present this amounts to over 5s. per ton, and the ash content in present day fuel is over 20 per cent. There are several electricity stations now using gas and oil for boiler-firing, and Mr. Fedden recommends that an agreement be drawn up covering all the liabilities of the company, the Corporation to take a supply of gas for ten years on the understanding that if the scheme is unsuccessful no expense will devolve upon the Corporation.

The Electricity Supply Committee propose to increase the charge from the end of the June quarter, from 40 per cent. to 50 per cent. on all units charged at over 2d. per unit; from 75 per cent. to 105 per cent. on all units charged at 2d. or under; and from 50 per cent. to 75 per cent. on all units supplied to the tramways.

An important report by Mr. J. H. Rider on the electricity supply was approved by NOTTINGHAM Corporation on Monday. In view of the alterations in the plans for the supply of electrical energy in the East Midland area, and the proposed erection of power stations in Nottingham and Leicester and the extension of the Derby station, the Electricity Committee, adopting the recommendations of Mr. Rider, advised the erection of a new power station on the Trent. The plant to be installed in the first instance would be two 10,000 kw. sets, but for future extensions either 20,000 kw. or 25,000 kw. sets would be employed. The estimate of the cost, including land, buildings, machinery, &c., is as follows: First section, for 20,000 kw. installed, £752,600, or £37·63 per kilowatt; first and second sections, for 40,000 kw. installed, £1,009,000, or £25·225 per kilowatt. These figures (which are based upon actual cost at present) include a certain amount of expenditure on behalf of the future, such as buildings sufficient for 40,000 kw. of plant. High-pressure feeder cables will be laid between the new station and Talbot-street and St. Ann's Well-road, at a cost of £50,000, and transformer plant would also be necessary at a cost of about £30,000 at Talbot-street, £35,500 at St. Ann's Well-road, and £33,000 at five local sub-stations.

When the first section of the new station is ready the Talbot-street will be shut down as a generating station, and St. Ann's Well-road plant need not be run for more than 16 hours per day. The economies to be gained by operating the new power station would be very great, the only drawback being the high capital charges, due to present conditions. The committee recommended the Council to authorise them to proceed with the scheme, to acquire the land and to accept tenders, also to apply to the Electricity Commission for their sanction to the scheme and to the borrowing of £868,600 for the first section.

Reporting on the financial aspect, the Finance Committee state that it has been ascertained that if the term for the repayment of the proposed loan is fixed at 23 years, the approximate annual charge for sinking fund and interest will be £75,839. 12s. 9d.

Electric Traction.

BRIGHTON Corporation has sanctioned the construction of an experimental section of a high-speed electric railway to connect Brighton with Rottingdean and Newhaven.

The AIRDRIE and COATBRIDGE Town Councils have agreed to purchase the undertaking of the Airdrie & Coatbridge Tramway Company for £77,500. The system, which is equipped on the overhead system, was opened in February, 1904. There are only 3·63 route miles of track.

York City Council recently decided to restore the penny tramway fares, but the tramways manager (Mr. J. W. Hame) reports that if a penny fare for half-mile stages is substituted for the present three-halfpenny mile stages, there will be a net reduction of £3,233 in income, to which must be added an estimated increased wages bill of £9,146, making a total adverse balance of £12,379. The surplus balance on last year's working was only £1,600. Mr. Hame is reporting on the question of increased fares to cover the cost of the working of the tramways.

For the year ended March 31 the revenue of the BIRMINGHAM Corporation tramways department was £1,378,704 (compared with £1,247,271 in 1918-19), and gross profit £284,082 (£318,741), and after adding balance from omnibus account the total was £302,561. A sum of £151,030 was required for interest and loan repayment charges, £136,324 has been allocated to reserve, and £15,147 to suspense account, the latter writing off balance of expenditure on the motor omnibus undertaking. Traffic revenue per car-mile on the tramways was 21·538d. (20·081d.), and working expenses were 17·184d. (15·013d.). Passengers carried were 225,129,814 (207,902,770) and car-miles run 15,288,095 (14,843,699). The capital expended was increased by £40,850.

The revised fares on the GLASGOW Corporation tramways have resulted in an increase of about £1,200 a day in receipts. For the year ended May 31, the traffic receipts were £1,716,499, an increase of £189,003 compared with the preceding year; the passengers carried numbered 509,339,886 (increase of 45,093,209); the car mileage run was 26,459,015, an increase of 877,468; the traffic receipts per car-mile were 15·570d. (increase 1·239d.), and the traffic receipts per passenger ·809d. (increase ·019d.), and the passengers carried per car mile numbered 19·250 (increase 1·102). There were 304,865,756 passengers at ½d. (increase 14,785,380), but the percentage of ½d. passengers to the total number carried fell from 62·48 to 59·86. The department's reputation as accurate record compilers cannot be beaten by any Government department for we learn among many other things that the weight of copper received during the year was 813½ tons, while that of silver was 145½ tons. Since the Corporation took over the tramways on July 1, 1894, the passengers carried have numbered 6,210,147,070, of whom 47·98 per cent. have been at the ½d. rate and 41·43 at the 1d.

The MANCHESTER Tramways Committee has been authorised to reduce the penny stage from two miles to a mile and a half. In a report by the general manager, Mr. J. M. McElroy, it was stated that the "all-in" costs per car-mile were 127 per cent. above, while the average fare paid per passenger was only 27 per cent. above the pre-war level. A considerable increase in the fares was essential if the department was to be kept financially sound. At present all passengers (both ordinary and workpeople) were being carried at workpeople's rates—a ½d. per mile—and there was much to be said in favour of a policy which called upon all passengers to pay alike. That could not be done, however, without power to increase the workmen's statutory fares, and it would be necessary to let existing fares stand as regarded workpeople. The proposed increase would therefore apply to ordinary passengers only.

In moving the adoption of the report, Dr. Chapman pointed out that already other large towns had increased the fares, Salford and Leeds now gave only one mile for a penny, and one town had no fare less than 1½d., whilst Birmingham's penny stages only exceeded 1¼ mile by 100 yards.

After discussion the recommendation to increase the fares was adopted

Telegraph and Telephone Notes.

In consequence of the seamen's strike, volunteers from the general community have been invited to man the cable steamer "H. C. Oersted," of the Great Northern Telegrah Company, which is going to lay SUBMARINE CABLES in the North Sea between Denmark and Great Britain.

The Air Ministry notify that the RADIO-TELEPHONE STATIONS at Croydon and Lympne are now open, and the French authorities have established similar stations at St. Inglevert, Valenciennes, Paris, Le Bourget, and the Belgian authorities are arranging one at Brussels. Stations will shortly be opened for the London-Birmingham-Manchester-Glasgow route at Castle Bromwich, Didsbury and Renfrew.

For some time there have been many complaints in the business circles of Sheffield about the INEFFICIENCY of the local TELEPHONE SERVICE, and a demand has been made for the introduction of the automatic system. The Post Office, proceeding in its usual leisurely fashion, announces that "the question is still being investigated, but all the circumstances point to a decision in favour of automatics being reached." In regard to the present telephone service and the slow progress of automatic telephony in this country our contemporary "Ways and Means" very pertinently states: "If business men were asked what most they wanted, nine out of ten would reply, 'Automatic telephones.' These would obviate that irritating event known as breaking-in. Our system, and not the operator, is to blame. A leading City man tells me that much of his business is done on the trunk line, and demands absolute accuracy. He assures me his mornings are nerve-racking affairs for all concerned. Automatic exchanges would be expensive to install throughout the country, but the best is still the cheapest for business transactions."

Institution Notes.

Application has been made to the Board of Trade for a licence to register the SOCIETY OF RADIOGRAPHERS with limited liability, without the addition of the word "Limited" to its name.

The NORTH-WESTERN STUDENTS' CENTRE OF THE INSTITUTION OF ELECTRICAL ENGINEERS has decided to arrange a summer meeting for Saturday, July 3, to Buxton, provided a sufficient number of students and friends send in their names before June 17. The secretary will also be pleased to receive the names of any members who are prepared to read a Paper during the coming session.

In a Paper on "Our Part in Steel Making," read before the last meeting of the IGRANIC ENGINEERING SOCIETY, Mr. C. W. Yerger described the various types of electric control gear, particularly those manufactured by the Igranic Electric Co., Ltd., which have been designed for use with the machines used in iron and steel works, and showed in the case of each how it was specially suited to the characteristics of the machine and the load that it was designed to control. The Paper was illustrated by numerous photographs.

In the 14th annual report of the SKILLED EMPLOYMENT AND APPRENTICESHIP ASSOCIATION, it is stated that during the year 1919 the committees received 1,303 applications, compared with 1,158 in 1918. Forty per cent. of the boys and 47 per cent. of the girls were successfully placed, and one-quarter of the boys and one-sixth of the girls were apprenticed. Among the boys' trades, the engineering and heavy metal trades remain the most popular, absorbing two-fifths, as in the previous year. The numbers in the instrument-making trades have fallen off, but the jewelry and light metal trades show a noticeable increase. Modifications of the constitution have been prepared, and the name of the Association has been changed to emphasise the skilled employment work.

The first annual general meeting of the WOMEN'S ENGINEERING SOCIETY was held last week at 46, Dover-street, W. The Hon. Lady Parsons presided, and reminded her hearers that women had really worked in connection with engineering for many years, but it was during the war that women got their chance.

Miss Rachel M. Parsons was elected president, Miss Selby hon. secretary, and the Hon. Lady Parsons as treasurer. A council was also elected. The annual report stated that the society was growing in strength. Meetings had been held during the year, and in December the society commenced to publish a small quarterly entitled the "Woman Engineer." A club room had been opened at 46, Dover-street, where technical books and papers were available for the use of members.

At the meeting of the Midland branch of the National Association of Colliery Managers at Nottingham on Saturday, Prof. W. H. McMillan gave some particulars of the recent improvements in MINER'S SAFETY LAMPS. After referring to oil lamps, he said the outstanding change which had taken place in underground lighting had been the introduction of a considerable number of different types of portable electric safety lamps, the chief advantage of which was that they gave a better light, and were safer than the oil lamp. He had carried out tests of electric and oil lamps in the laboratory, and he found that the average light-giving power of the electric lamps at the end of ten hours was approximately equal to that of oil lamps at the beginning. Prof. McMillan also stated that at one of the collieries of the Butterley Company, where the electric lamp replaced the oil lamp, at the end of one year's working the number of new cases of nystagmus had been reduced by 40 per cent., and at the end of three years by nearly 70 per cent. Though the electric lamp was slightly more expensive to maintain, there was a general opinion that the many advantages arising from the better light, greater reliability and smaller risk of gas explosions more than compensated for its extra cost.

The annual report of the Association of Consulting Engineers calls attention to the large amount of important work that has been done by the committee during the past year. A model general set of conditions for use in work carried out on a prime cost and profit basis has been drawn up, and consultations have been entered into with the Federation of Civil Engineering Contractors regarding the form of overriding clauses to be inserted in all engineering contracts. At present these do not meet with the approval of the Association. The Institution of Electrical Engineers invited the Association to confer with them on the question of the model set of general conditions of contract for electrical work which have been drawn up by the Institution, and very satisfactory work from the Association's point of view has been done in this respect. The action recently taken by the Committee of the Association towards an advance of 50 per cent. on pre-war rates in engineers' remuneration has been supported by the Council of the Institution of Civil Engineers. The Foreign Office and the Board of Trade have recently written to the Association, suggesting that members visiting foreign countries should give notice to the Department of Overseas Trade of their intention, so that arrangements can be made for assistance to be given them by Consular and other officers. It is satisfactory to note the undesirability of P.W.D. officers in India doing consulting work has been recognised by the department concerned.

Educational.

The General Electric Company has given £1,000 to the fund for establishing a DEGREE OF COMMERCE AT THE UNIVERSITY OF LONDON.

A research laboratory is being erected for the textile department of LEEDS UNIVERSITY, and investigations are being conducted into the electrification of fibres which takes place in the manipulation of wool. Following the example of Manchester and Liverpool Universities an appeal is being made for £500,000 for the extension of educational and research facilities.

Miscellaneous.

On Wednesday the King, who was accompanied by the Queen and Princess Mary, formally opened the Imperial War Museum at the Crystal Palace. In addition to a number of interesting naval and military exhibits there are also collections of engineering and electrical appliances. particulars of which we hope to give in an early issue.

We regret to record the death of Prof. Augusto Righi, Professor of Physics at Bologna University. He was born in 1850, and educated at Bologna University, where he was assistant in the department of physics in 1872-3. From 1873 to 1880 he was professor of physics at Bologna Technical Institute. Subsequently he was professor at Palermo and Padua Universities, but in 1890 he returned to his native town. He was author of about 250 Papers on physics and electrical subjects, mainly on electrical oscillations, Rontgen rays, &c. He was a member of many Italian and foreign learned societies ; he was an honorary Fellow of the Physical Society of London, of the Royal Institution and of the Royal Society of Edinburgh. In 1905 he was awarded the Hughes medal of the Royal Society, of which he was a correspondent.

About 500 past and present members of the London Electrical Engineers, R.E. (T.A.), were present at the Cannon-street Hotel on Wednesday of last week to inaugurate an Old Comrades' Association. The proceedings opened with a concert which from the artistes' point of view was hardly a success, as so many old friendships were being renewed, new ones made and wartime exploits discussed that the music, singing and recitations were quite drowned. In the course of the evening Col. A. E. Le Rossignol, C.B., dealt briefly with the work which the corps had done during the war, and formal resolutions laying down a scheme for founding an Old Comrades' Association and appointing a provisional committee were proposed by Major Edgcumbe and Major Rich and carried unanimously. The Association is open to all past and present members of the corps. Two reunions will be held a year, the cost of which will be covered by an annual subscription of 10s. 6d., which, if paid at once will run to October, 1921. Headquarters will be opened on certain evenings in the week where facilities for social intercourse will be provided. It is hoped to publish at an early date a list of members of the corps with their war services, and all those interested are particularly requested to communicate with the Hon. Secretary at 108, Heathwood-gardens, Charlton, S.E. 7, giving their own addresses and the addresses of ex-members known to them. An annual meeting with a concert will be held in October when a committee will be elected.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during April, 1920, and (*b*) the aggregate figures from Jan. 1 to April 30, with increase or decrease compared with corresponding periods of 1919 :—

Electrical machinery, (*a*) £86,321 (increase £22,351), (*b*) £342,124 (increase £172,206) ; telegraph and telephone cables other than submarine, (*a*) £570 (increase £507), (*b*) £2,204 (decrease £5,178) ; telegraph and telephone apparatus, (*a*) £14,609 (decrease £15.993), (*b*) £47,539 (decrease £38,503) ; other electrical wires and cables, rubber insulated, (*a*) £5,180 (increase £5,180), (*b*) £8,725 (increase £6,242) ; with other insulations, (*a*) £1,746 (decrease £2,050), (*b*) £19,002 (increase £10,633) ; carbons, (*a*) £6,616 (increase £5,411), (*b*) £44,378 (increase £36,104) ; glow lamps, (*a*) £1,967 (decrease £54,037), (*b*) £10,781 (decrease £123,777) ; arc lamps and electric searchlights, (*a*) £1,140 (increase £1,140), (*b*) £2,480 (increase £2,480) ; parts of arc lamps and searchlights (other than carbons, (*a*) £722 (decrease £3,205), (*b*) £4,994 (decrease £20,687) ; batteries, (*a*) £9,900 (increase £8,705), (*b*) £24,207 (increase £9,968) ; meters and measuring instruments, (*a*) £4,264 (increase £1,767), (*b*) £19,122 (increase £6,213) ; switchboards, (*a*) £17 (decrease £325), (*b*) £973 (increase £301) ; electrical goods and apparatus unenumerated, (*a*) £56,545 (increase £23,512), (*b*) £174,224 (increase £9,168). Total of electrical goods and apparatus other than machinery and uninsulated wire, (*a*) £103,276 (decrease £29,388), (*b*) £358,679 (decrease £106,982).

Exports.—The exports of electrical machinery, material, &c., (*a*) during April, 1920, and (*b*) from Jan. 1 to April 30, with increase or decrease compared with corresponding periods of 1919, were as follows :—

Electrical machinery, (*a*) £183,485 (increase £68,853), (*b*) £640,528 (increase £242,070) ; including railway and tramway motors, (*a*) £2,034 (increase £509), (*b*) £9,531 (decrease £10,378) ; other generators and motors except for aeroplanes, motor cars and cycles, (*a*) £94,507 (increase £38,341), (*b*) £353,328 (increase £148,738) ; and electrical machinery unenumerated, (*a*) £86,944 (increase £30,003), (*b*) £277,669 (increase £103,710); telegraph and telephone cables, submarine, (*a*) £88,278 (increase £1,194), (*b*) £512,821 (increase £347,092) ; other than submarine, (*a*) £87,727 (increase £73,017), (*b*) £304,083 (increase £201,471) ; telegraph and telephone apparatus, (*a*) £80,450 (increase £51,660), (*b*) £383,187 (increase £284,887); other electrical wires and cables, rubber insulated, (*a*) £121,048 (increase £83,332), (*b*) £464,251 (increase £347,067) ; with other insulation, (*a*) £145,565 (increase £99,293), (*b*) £531,596 (increase £409,401) ; carbons, (*a*) £10,202 (increase £9,418), (*b*) £30,299 (increase £27,839) ; glow lamps, (*a*) £15,315 (increase £7,378), (*b*) £55,055 (increase £21,010) ; arc lamps and searchlights, (*a*) £378 (decrease £2,914), (*b*) £5,224 (decrease £969) ; parts of arc lamps and searchlights (other than carbons), (*a*) £1,376 (increase £738), (*b*) £3,699 (decrease £3,209) ; primary and secondary batteries, (*a*) £35,382 (increase £6,039), (*b*) £135.317 (decrease £31,588) ; meters and measuring instruments, (*a*) £36,357 (increase £11,164), (*b*) £106,085 (increase £45,827) ; switchboards, (*a*) £5,550 (increase £4,224), (*b*) £29,186 (increase £17,081) ; electrical goods and apparatus unenumerated, (*a*) £127,901 (increase £47,864), (*b*) £467,757 (increase £145,035). Total of electrical goods and apparatus, other than machinery, (*a*) £756,529 (increase £392,407), (*b*) £3,028,560 (increase £1,810,944).

Tenders Invited and Accepted.

Johannesburg (Transvaal) Corporation want tenders by noon, June 28, for Electricity Meters and Time Switches (contract 611).

Edinburgh Corporation require tenders by June 19, for e.h.t. and l.t. switchgear for Portobello station. Specifications from the Engineer.

Blackburn Corporation want tenders by 10 a.m., June 14, for wiring 136 houses on Green-lane site. Specifications, &c., from the Borough Engineer.

Carlisle Corporation require tenders by June 25 for 3,000 kw. turbo-alternator and condensing plant. Specifications from City Electrical Engineer.

Nuneaton Corporation require tenders by 9 a.m., June 30, for 1,000 kw. d.c. geared turbo-generator surface condensing plant and pipework. Specifications from the Borough Electrical Engineer.

Halifax Tramways and Electricity Committee require tenders by noon, July 8, for two natural draught chimney type water cooling towers. Specifications from the Borough Electrical Engineer.

Toxteth Park guardians require tenders by June 21, for three months' electrical and engineers' supplies. Forms of tender from the Clerk, 15, High Park-street, Liverpool.

Nottingham Electricity Committee require tenders by June 17 for twelve months' supply of general stores. Forms of tender from the Electrical Engineer.

Warrington Electricity and Tramways Committee require tenders by June 15 for motors and transformers. Specifications from Borough Electrical Engineer.

Nuneaton Corporation invite tenders for a 1,000 kw. d.c. turbo-generator, surface condensing plant and pipework. Tenders to Chairman of Electricity Committee by June 30.

Dundalk Urban Council require tenders by 6 p.m. June 15 for l.t. three-cored paper-insulated lead-covered and armoured cable and joint boxes. Specifications from the Engineer and Manager.

Tenders are invited for the equipment and running of electricity supply works at Cape Coast and tramways at Coomassie (Gold Coast). Further information from the Secretary for Works, Accra. Tenders to the Colonial Secretary, Victoriaborg, Accra, by Sept. 1.

Ince-in-Makerfield Urban Council require tenders by June 15, for (1) two electric motor-driven turbine vertical duplicate pumping sets ; (2) two horizontal ditto ; (3) cables ; (4) conversion of winding engine to electric drive ; (5) switchgear. Specifications from the Clerk.

Leeds City Council invite tenders for a steam turbine, three-phase alternator and exciter of 1,200 kw. capacity. Specifications from the manager of the electricity department, Mr. C. Nelson Hefford, and tenders to the Town Clerk, 26, Great George-street, Leeds, by June 14

Bedford Corporation electricity department invite tenders for the supply and erection of one 2-ton locomotive jib crane, grab and track rails, and steam and other pipework. Specifications from the borough electrical engineer, Mr. R. W. L. Phillips, to whom tenders by June 21.

Newport (Mon.) Corporation invite tenders for turbo-alternator and surface condensing plant, boiler, economisers, draught plant, &c. Specifications from the borough electrical engineer and tramways manager, Mr. A. Nichols Moore ; and tenders to the Town Clerk, by June 26.

The Tramways and Electricity Committee of Halifax Corporation invite tenders for the supply and delivery of two natural draught chimney-type water-cooling towers. Specifications from the borough electrical engineer (Mr. W. M. Rogerson) and tenders to the town clerk (Mr. Percy Saunders) by noon, July 8.

Marylebone (London) Borough Council has accepted the tender of Ferguson, Pailin, Ltd., for e.h.t. switchgear at £12,448 ; that of H. J. King & Company for pneumatic coal-handling plant (£4,500), and that of the Lea Recorder Company for Lea recording apparatus, £266.

Hammersmith (London) Council has accepted the following tenders : Electrical Apparatus Co., meters, £662 ; W. Lucy & Co., house service and fuse boxes, £374 ; Ferguson, Pailin, Ltd., switchgear, &c., £11,107 (eight tenders varying from that of the accepted to £27,260) ; Sankey & Co., cable ducts, £3,511.

Bankruptcies and Liquidations.

A meeting of creditors of the Surrey Electrical Company, Ltd., will be held on June 17 at 227-8, Gresham House, Old Broad-street, London, E.C.2.

A meeting will be held at 4, Central Bank-chambers, Leeds, on July 6, to receive an account of the winding up of the Electric Train Lighting Syndicate, Ltd.

Claims against Walter P. O'Reilly, electrician, lately trading at 397 and 399, Edgware-road, W., and 124, Old Broad-street, E.C., London, are to be sent to Mr. D. Williams, Bankruptcy-buildings, London, W.C., by June 18.

The Electric Smelting Company, Ltd., is being wound up voluntarily and Mr. G. A. V. Narraway, 35, Queen Victoria-street, London, E.C., has been appointed liquidator. A meeting of creditors will be held at 35, Queen Victoria-street, on June 14.

Cuthbert J. T. Hayman, electrical engineer, lately trading at 96, Woodhouse-road, Leytonstone, and 1, Goodmayes-road, Goodmayes, Essex, has been adjudicated bankrupt. First meeting of creditors on June 15, and public examination on July 16, both at Bankruptcy-buildings, London, W.C.

Personal and Appointments.

Mr. L. Ostick, of Bridlington, has been appointed mains assistant at Finchley.

Mr. E. L. Shoesmith has been appointed charge engineer at Dover at a commencing salary at £200 per annum.

Mr. A. S. Hoppell, of Southend, has been appointed charge engineer at Torquay.

Motherwell Corporation has increased the salary of the Borough Electrical Engineer (Mr. Wishart) from £450 to £550 a year.

Mr. H. Richardson, M.Sc., of the College of Technology, Manchester, has been appointed Principal of the Bradford Technical College.

Mr. Wm. Stevenson, telegraph and electrical engineer to the Caledonian Railway Company, retires from the service of the company at the end of this month, and he is to be succeeded by his chief assistant, Mr. Alfred Smyth Hampton.

Colonel H. G. Lyons, D.Sc., F.R.S., has been appointed Director and Secretary to the Science Museum, in succession to Sir Francis Ogilvie, C.B., LL.D., who has been transferred to the Department of Scientific and Industrial Research.

Prof. E. Nichols has resigned the chair of physics at Yale University, in order to undertake the position of director of pure science in the N.E.L.A. laboratories of the National Lamp Works of the General Electric Company, Cleveland, Ohio.

Mr. A. C. Bloomfield has been promoted to the position of Superintendent (Section A) of the Central Telegraph Office, London. Mr. F. G. Ramsay becomes commander of the Cables Ships Establishment; and Mr. E. R. Hutchons and Mr. G. H. Flavel, Chief Officers.

Mr. O. F. Brown, M.A., B.Sc., Assistant Inspector of Wireless Telegraphy in the Post Office, has been appointed Technical Officer to the Radio Research Board, which has recently been formed under the Chairmanship of Admiral Sir Henry Jackson, in connection with the Department of Scientific and Industrial Research.

Additional promotions in and appointments to the Order of the British Empire have been made for services in connection with the war. Among the latest list are Capt. T. W. Smythe, Master of the Eastern Telegraph Company's cable ship "Electra," and Capt. John Wilson, chief electrical engineer of the Buenos Aires Western Railway and superintendent engineer of the Shandon Experimental Station, who have been created O.B.E.s.

The following are among the persons to whom the King has granted permission to wear Foreign Decorations conferred in recognition of valuable services rendered during the war:

Chevalier of the Order of The Redeemer (conferred by the King of the Helenes): Edmund L. Hill, M.I.Mech.E., M.I.E.E., General Secretary of the Federation of British Industries; *Chevalier of the Order of The Crown* (conferred by the King of the Belgians): H. F. Van der Meulen, Superintendent of Cable Room Staff, Central Telegraph Office.

Among the King's Birthday Honours we notice the following: *Baronets*: Sir George A. Touche, Chairman of the Anglo-Argentine Tramways, the United Electric Tramways of Montevideo, and the Cordoba Light, Power & Traction Company. *Knights*: Wm. B. M. Bird, founder of the Salters Institute of Industrial Chemistry; Philip Dawson, M.I.C.E., M.I.E.E. (Consulting Electrical Engineer and Member of the Disposals Board, Ministry of Munitions); Prof. Jas. B. Henderson, Royal Naval College, Greenwich; and Wm. Noble, Chief Engineer, General Post Office.

Major Sir Philip Dawson, M.I.C.E., M.I.M.E., M.I.E.E., is a partner in Messrs. Kincaid, Waller, Manville & Dawson, the well-known consulting engineers, of Westminster. He is consulting electrical engineer to the L. B. & S. C. Railway Company, and is responsible for its electrification, also consulting engineer of the Great Eastern Railway, &c. He has been a member of the Disposals Board of the Ministry of Munitions practically since its inception. He is a member of the Railway Electrification Advisory Committee of the Ministry of Transport, a member of the Water Power Resources Committee, and he is the author of many well-known text-books on electric traction and power supply. He holds the George Stephenson Gold Medal of the Institution of Civil Engineers and the Prince Albert Medal of the Society of Arts. He is also vice-president of the Belgian Royal Commission to report on the electrification of the Belgian State Railways and on the unification of Belgian electric power supply, and he is president of the Association des Ingenieurs Electriciens of the Institute Electrotechnique Montefiors, Liege. Sir Philip Dawson, who was one of the founders of the Sydenham Forest Hill National Defence League, is a member of the L.C.C. and is on the Housing, Highways and Electricity Committees.

Business Items, &c.

Messrs. Downes & Davies, electrical merchants, of Liverpool, have removed their Manchester office to 25-27, Faulkner-street.

Messrs. Higgs Bros., of Birmingham, have issued their June stock list (with prices) of motors and dynamos.

Mr. E. M. Parsons, Electrical Contractor, who has been established at Hull for over 17 years, has removed to larger and more convenient premises at 38a, Brook-street. The telephone number remains Central 5180.

Mr. A. B. Cartland, A.M.I.E.E., has secured an office at 3, Creechurch-lane, Leadenhall-street, London, E.C. 3, where he proposes to specialise in fuel economising and smoke abatement appliances, including the patent Sandwich system of boiler firing, and the Gallagher Crompton baffle bridge and boiler efficiency calculator.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1916 Specifications.

141,[illegible]6 B. T.-H. Co. (G. E. Co.). Wireless telephone systems. ([illegible] 10 16.)

Two [illegible] provided at each end of the transmission [illegible] for transmitting [illegible] for receiving. A source of [illegible] alternating current [illegible] with each transmitting aerial as well as [illegible] for controlling the radiation [illegible] aerial in accordance with the speech [illegible] operator. In addition [illegible] provided so that a telephone [illegible] connected to a central [illegible] be connected simultaneously with both the receiving and transmitting [illegible]. The two antennæ are located at a great enough distance from each [illegible] the effect of the transmitted signals may be [illegible] in the [illegible].

1917 Specifications.

141,[illegible]87 B. T.-H. Co. (G. E. Co.) Electric motor control systems. (15 [illegible] 17.)

1918.

141,080 Western Electric Co., Polinkowsky, Hackley & Deaken (Western Electric Co. & Stevens, in part). Machine-switching telephone systems. ([illegible] 18.)
141,081 Western Electric Co. & Polinkowsky (Western Electric Co., in part). Machine-switching telephone exchange systems. (25 2 1918.)
141,083 Western Electric Co. & Polinkowsky. Machine-switching telephone exchange systems. (27 2 18.)
141,084 Imray (Bosch Akt.-Ges.). Regulating-device for dynamo-electric machines. (2 7 18.)
141,099 Carey. Shaded pole motors and the like. (5 12 18.)
141,101 Lyon & Wrench, Cooper & T[illegible]man. Manufacture of electric-dynamos and motors. (6 12 18.)
141,106 Sterling Telephone & Electric Co. & Davey. Automatic telephone exchange systems. (31 12 18.)
141,404 Gr[illegible]z. Electrical firing of explosive mines. (17 12 18.)

1919.

132,498 Scintilla. Magneto-electric ignition apparatus for internal-combustion engines. (13/9 18.)
133,296 Scintilla. Adjustment for toothed wheels in magneto-electric ignition apparatus for internal-combustion engines. (1/10 18.)
134,519 Hewlett. Electric switches. (31 10/18.)
134,543 Westinghouse Electric & Manufacturing Co. Electric-switching mechanism. (30/10 18.)
141,116 Harman & Le Bas. Dynamo-electric machines. (3/1 19.)
141,121 British Thomson-Houston Co. & Wedmore. Protective devices for alternating-current electric distribution systems. (6 1 19.)
141,150 Arnold. Devices for indicating the position of electric switches, gas-fittings, or the like in rooms or other places. (14 8 19.)
141,154 Pestarini. Electric regulator of the induced-current motor type. (19/2 19.)
141,170 Pfenninger. Electrical steam-generating plants. (13 3/19.)
141,182 British Thomson-Houston Co. (General Electric Co.) Fastening of metal bases to glass vessels such as electric incandescent lamps. (29/3/19.)
141,185 Bardeloni. Receiving methods of radio-telegraphic and radiotelephonic signals. (3/10/16.)

Comprises ionized gas receivers with at least two electrodes, in addition to the incandescent filament, comprising a rectifying device for currents of variable direction inserted upon a circuit which acts directly on the currents set up, through the effect of the oscillating circuit, between the electrodes of the ionized gas receiver connected to same, in such manner as to vary the current produced in the circuit on which is inserted the receiver, telephone, or the like.

141,188 Browne & Heywood & Co. Electrical resistance devices. (5/4/19.)
141,190 Murray, Erskine & Robinson. Wireless receiving and transmitting apparatus. (10 4/19.)
141,195 White. Delay-action electric switches. (23/4/19.)
141,217 Norton. Operating and tripping mechanism of oil-break electrical switches. (21/5/19.)
141,225 Barbour & Walton. Electric control gear for dynamo-leectric machines. (29/5/19.) (Cognate application 29,826/19.)
141,231 Shillito. Direct-current dynamo-electric machines. (5/6/19.)
141,232 Vickers, Ltd., & Baerlocher. Electric transformers. (5/6/19.)
141,243 Clarke & Price. Field telegraph and telephone exchanges. (24/6/19.)
141,269 Ryan. Wireless telegraphy and the like. (28 8/19.)
141,285 Ferranti, De Wall & Ferranti, Ltd. Measurement of the Wattless component of alternating electric current power. (22 10/19.) (Addition to 137,090.)

Consists in the employment of a resistance in parallel with the series coil of electricity meters adapted for the measurement of the Wattless component of alternating power.

141,294 Zumbuhl. Electric switches for controlling electrically-heated apparatus. (21/6 19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

January 14, 1920.

1,149 Knight. Thermo-electric valve.
1,152 Greenhalgh & Longbottom. Electric welding.
1,157 Francois. Electric irons. (12/3/18, France.)
1,180 Kitchin. Electric switch.
1,187 Kitchin. Holders for thermionic valves.
1,216 Slaby. Battery arrangements for small electric vehicles. (22/1/19, Germany.)
1,223 Cox. Electrical indicator for oil pressure or petrol engines.
1,249 Radio, Ltd., & Donisthorpe. Radio-telegraphic and telephonic apparatus.

January 15, 1920.

1,278 Spencer. Electric lamp filament protector.
1,302 Jennison. Trolly wheel on contact control mechanism.
1,314 Siemens Bros. Dynamo Works & Crowley. Electric motor driving arrangements.
1,318 Conway. Electrical fire and burglar alarm.
1,319 Gleet[illegible]n. Tumbler switches.
1,383 Metropolitan-Vickers Electrical Co. Utilisation of tidal energy for production of power.
1,384 Metropolitan-Vickers Electrical Co. Armatures for dynamos. (16/1/19, U.S.)
1,385 Akt. Ges. R. Bosch. Ignition apparatus for engines. (17 10/18, Germany.)
1,386 Akt. Ges. R. Bosch. Electrical condensers. (15/3/15, Germany.)
1,388 Akt. Ges. R. Bosch. Ignition apparatus for engines. (21/1/18, Germany.)
1,390 Akt. Ges. R. Bosch. Portable generating sets. (26 1/18, Germany.)
1,391 Akt. Ges. R. Bosch. Device for preventing sparking in electric ignition circuit when lead becomes broken. (5/1/18, Germany.)
1,398 Duthoit. Medical electrodes.

January 16, 1920.

1,402 Automatic Telephone Mfg. Co., Smith & Sergeant. Indicating arrangement for underground railways, &c.
1,415 Ewart. Means for timing electric ignition apparatus.
1,475 Hepburn. Electrolysers.
1,498 Akt. Ges. R. Bosch & Imray. Electric starting devices for engines.
1,499 Akt. Ges. R. Bosch & Imray. Magnetos.

Companies' Reports, &c.

The directors of the British Electric Traction Company, Ltd., recommend a dividend of 4 per cent. on the ordinary stock for the year ended March 31, 1920, carrying forward £150,000.

Letters of allotment in respect of the recent issue of preference and ordinary shares by the Stoll Picture Productions, Ltd., have been posted.

Mr. R. J. Howley, who presided over the recent meeting of the Potteries Electric Traction Company, Ltd., said that there was an increase in receipts of £46,221 owing to a small increase in the total number of passengers and a further increase in fares. The 48-hour week had caused the largest single increase in wages which they had had to meet in any year, being equivalent to some 13s. per man per week on the old basis of a 60-hour week. In November an increase of 4s. a week was granted, and now there was a further increase of 8s. per man per week, which would rise to 9s. on June 1. Increases in wages during the year had outdistanced the increased cost of living, and there must be some finality to the increases which could be granted. They were paying a dividend of 5 per cent. on the ordinary shares, and carrying forward £12,081. With regard to the negotiations for the sale of the undertaking to the Corporation, the necessary majority of the ratepayers had not been obtained and the Bill had been withdrawn. The shareholders need not feel dejected; the undertaking was a good property, well maintained, and, on a sale under the terms of the Tramways Act of 1870, should realise a substantial amount.

The directors of the United River Plate Telephone Company, Ltd., report that the gross earnings for the year 1919 amounted to £976,168, whilst the gross maintenance and other charges in Argentina and London were £764,076, leaving a profit of £212,092. Deducting interest on debenture stock, the preference dividend and the interim dividend on the ordinary shares (£72,100), and adding amount from previous year (£36,707), the balance is £176,700. The directors recommend a final dividend of 5 per cent. on the ordinary shares, making (with the interim dividend) a total of 8 per cent. for the year, tax free (£81,000), placing £50,000 to reserve, and £10,000 to reserve (war contingencies) fund, leaving £35,700 to be carried forward. In continuation of the policy of the company to keep abreast of the progress and development of the telephone industry, and to place at the disposal of its subscribers the advantages of the latest improvements, the directors have sanctioned the introduction into Buenos Aires of the automatic system. The general expansion of the undertaking of the company, and the necessity of coping with the ever-increasing demand for new telephone facilities, entail an outlay which can only be met by the provision of additional capital, and a resolution will be submitted to the shareholders increasing the authorised capital to £2,500,000.

The directors' report of the Marconi International Marine Communication Company, Ltd., for 1919, states that the business continues to show substantial expansion. The gross revenue for the year was £772,019, an increase over 1918 of £208,813. This increase is in part due to an increase in ship subsidies in consequence of a large advance in salaries of telegraphists, and is counterbalanced to a considerable extent by increased expenditure. In consequence of the unfavourable rates of exchange at the end of the year, considerable sums have been allowed to remain abroad on deposit or invested in foreign Government securities. A sum approximating £50,000 has been debited to profit and loss account, calculating the rate of exchange on Dec. 31 as though the money had been brought home at that date, and the loss incurred. Notwithstanding this temporary depreciation and the writing off of £20,000 representing depreciation in investments in Government securities, the profit shows an increase over the preceding year. The directors recommend payment of a final dividend of 10 per cent., which, with the interim dividend of 5 per cent. paid in January last, will make 15 per cent. for the year. The number of public telegraph stations owned and worked by the company on the high seas increased from 2,549 in 1918 to 2,842 at the end of December, 1919. The Amalgamated Wireless (Australasia), Ltd., has paid a dividend of 5 per cent. for the year ended June 30, 1919.

The report of Callender's Cable & Construction Company, Ltd., for 1919 show credit balance of £161,525. Deducting debenture interest, preference dividend and the appropriations for depreciation of buildings, plant and machinery, &c., there is a balance of £84,025. With £114,779 brought forward the available total is £198,804. The directors recommend a dividend on the ordinary shares at rate of 15 per cent., less tax (being 3s. per share), of which 1s. per share was paid in November; placing £33,000 to special reserve for war taxation, and carrying forward £105,803. It is stated that during the year an entire change took place in the business of the company, as the factories both at Erith and of the Anchor Company at Leigh have been converted from manufacturing war materials to ordinary commercial production. Output was seriously interfered with, but the change-over is now complete, with most satisfactory results. In the early part of the year it became evident that additional plant and machinery were required to meet the increasing demands of the industry for cables capable of working at much higher voltages than in the past. Extensive new workshops were erected for the manufacture of super tension mains of 33,000 volts and upwards, and these are now practically completed. The Picardy works which were specially erected and equipped with machinery for the rapid manufacture of field telephone cables for the army, have been completely converted and equipped with plant for the manufacture of telephone cables for general use. The directors believe that the full results of the new plant will only be apparent in the future, and seeing that the volume of orders obtained is exceptionally large they have every hope that the financial results of the current year will be even more favourable. It has become apparent that the financial resources of the company, even with the additional capital issued in 1918 have not sufficiently met the requirements of the company's increasing trade, consequently the directors early in April took the necessary steps to increase the capital by the creation of 400,000 "B" cumulative preference shares of £1 each. These will be issued shortly, together with the balance of 100,000 ordinary shares.

The directors' report of the Austin Motor Company, Ltd., for 1919 states that the net profit is £237,866. Adding the balance from 1918 (£656,081) and deducting ordinary dividend for 1918 (£65,000), the available total is £828,947. The dividends on the 7 per cent. preference and 6 per cent. "B" preference shares have been paid, and it is proposed to give a bonus of one ordinary share for every two ordinary shares held (£200,000), to write £88,303 off expenses of issue of "B" preference capital and £35,000 off cost of flying ground, to carry £425,000 to general reserve, and to carry forward £13,995. During the year the works have been largely engaged on the difficult task of reconstruction and reorganisation. In spite of the work entailed in the change-over, satisfactory progress was made until mid-October, when the disastrous moulders' strike completely upset the plans for production and finance, making it necessary for the directors to seek for additional capital much earlier than had been anticipated. It is satisfactory to note that the output is increasing rapidly, and already up to schedule on chassis and tractors for the capital at present issued. The lorries and lighting sets are also making good progress, and will be in a similarly strong position before the end of July. The demand for the company's products has far exceeded expectations; in fact, the present schedule of output of the Austin twenty and agricultural tractor could be absorbed many times over in foreign markets alone. The company is pursuing a definite policy of sending a large portion of the production abroad in order to safeguard its foreign markets. The work of reorganisation and reconstruction has been practically finished, and the large capital expenditure necessitated by the establishment of such a huge undertaking as is now controlled by the company is rapidly approaching completion. Sir R H. Brade, G.C.B., has accepted a seat on the board.

In moving the adoption of the report, the chairman (Sir Herbert Austin, K.B.E.) pointed out that, in order to meet the clamant demand for a big decrease in the cost of living and a replacement of the amenities of civilisation as in pre-war days, we must have greater efficiency and more effective output. We must produce more food and more necessities within our own shores. Railway services can only be installed over a long period. Road locomotion and traction must supply their place, for the present at any rate. The shareholders might look forward with confidence to the future. But to secure the results desired and enable the efforts of the works to be fully effective the finances of the company should be sufficient to give ample scope, and to relieve any anxiety as to being able to meet all contingencies. It was with that desire that the directors decided to recommend the increase of the capital in February last to £5,000,000. At that period negotiations were in progress for an amalgamation of interests with a large American "combine," which it was considered would remove some of the possible competition in our foreign markets, and to carry that prospect into effect 1,850,000 ordinary shares were reserved to be issued should the negotiations be successful.

Siemens Brothers Meeting.

The directors of Siemens Brothers & Company, Ltd., have declared a final dividend of 5 per cent. (1s. per share), tax free, for the past half-year, making 10 per cent. for the year, after placing £5,000 to buildings reserve, £7,329 to pension fund contribution and retiring allowances, writing off £25,000 from discount on sale of debenture stock, and placing £15,000 to general reserve (making £75,000), carrying £315,776 forward.

Mr. G. Mure Ritchie presided over the meeting on Tuesday and stated that the net profit for 1919 was £211,209, compared with £229,647 for 1918. The dividends and appropriations absorbed £140,000, leaving £71,209 to pay the excess profits duty, and with £244,567 from 1918 an amount of £315,776 would be carried forward. He stated that the sale of the Stafford works arose out of lengthy negotiations with the English Electric Company. As modern developments in electric power plant tended in the direction of larger and ever larger units it became obvious that that branch of the business would require ultimately extensive additions both to the works and staff. They had made a friendly business agreement with the English Electrical Company for mutual support and for the purchase of the products of either company which may be required for the other's contracts. For needed extensions, about 2½ acres of land had been purchased on the riverside, and about 5½ acres had been taken on lease for 99 years.

Since the conclusion of peace the demand for submarine telegraph and telephone cables was very large, and substantial contracts had been completed or were still in hand for various Governments and cable companies, including the Danish and Norwegian Governments (for whom they had made special types of inductance loaded submarine cables of a larger capacity than any hitherto made), and the Eastern, Western Union and Central & South American Telegraph Companies. For electric light and power cables the demand was great and still growing, and their manufacturing facilities had been employed to the utmost, and that had also occurred in the case of the output for the development of the telephone service by the Post Office, for whom they had made and laid cables in a number of towns in the Northern and Scottish districts. The cable ship "Faraday," after repairing the Direct United States Company's cable in the summer, was employed during the autumn and winter carrying freight, but was now back on her regular work. Among the orders secured during the year was the contract for the supply of the cables for the electrification of the Great Western Railway from Shepherd's Bush to Ealing. They had also been successful in obtaining several large orders from abroad for e.h.t. cables. A considerable increase in sales of cable accessories and joint boxes had taken place and several large contracts had been entered into with corporations and municipalities for these goods. The trading in rubber insulated wires and cables showed an increase over any pre-war year and their "Stannos" wires were now in great demand. For their ebonite the demand far exceeded the supply. The battery business had been fully maintained and the construction of overhead lines for telegraph and power purposes had been revived; there was every sign of considerable business in the construction of power transmission lines. In spite of reconstruction and other difficulties the demand for their products was so great as rapidly to fill their order book. The business in telegraph apparatus had revived satisfactorily, and continued, as before, to be most exclusively for export. Their chief customers were foreign Government or railway administrations. Special signalling apparatus for winding operations in mines, which has been developed by them, was being largely adopted. The business in wireless telegraph installations continued to develop satisfactorily. The Post Office had placed considerable orders for telephone exchanges and the company booked no less than three public exchanges during the war. The demand for telephone exchanges in this country and abroad was far in excess of the pre-war demand and would continue for some years. The demand was chiefly for manually operated exchanges, but the future development of automatic telephony was assured, and was, in fact, being limited at present chiefly by the lack of sufficient manufacturing facilities. Arrangements had recently been made which would ensure the manufacturing output of their lamps being doubled in the near future.

Prices of Metals, Chemicals, &c.

Tuesday, June 8.

		Price.	Inc.	Dec.
Copper—				
Best selected………	per ton	£107 0 0	£1 0 0	—
Electro Wirebars…	,,	£110 0 0	£3 0 0	—
H.C. wire basis……	per lb.	1s. 3¼d.	$\frac{5}{16}$d.	—
Sheet………………	,,	1s. 5¼d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis………	,,	1s. 8¼d.	$\frac{5}{16}$d.	—
Brass 60/40—				
Rod, basis …… ..	,,	0s. 11d.	—	—
Sheet, basis………	,,	1s. 3¾d.	¼d.	—
Wire, basis………	,,	1s. 3¾d.	¼d.	—
Iron—				
Cleveland Warrants	per ton	£11 17 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£51 0 0	—	—
Lead Pig—				
English……………	,,	£38 0 0	—	£3 10 0
Foreign or colonial	,,	35 10 0	—	£3 10 0
Tin—Ingot……………	,,	254 0 0	—	£21 0 0
Wire, basis………	per lb.	0 3 4	—	3d.

Salammoniac.—Per cwt. 105s.–100s.
Sulphur (Flowers).—Per ton £19.
,, (Roll Brimstone).—Per ton £19.
Sulphuric Acid (Pyrites, 168°).—Per ton, £8 8s. 9d.

Copper Sulphate.—Per ton £44
Boric Acid (Crystals).—Per ton £74.
Carbon Bisulphide.—Per ton £60
Sodium Bichromate.—Per lb. 1s. 11d.
Sodium Chlorate.—Per lb. 5½d

Rubber.—Para fine, 2s. 1¼d.; plantation 1st. latex, 2s. 1d. per lb.
Shellac.—T.N. Orange, 590s. to 600s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Company, Ltd.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics":—"The Truth about German Flying"; "Our Dinner to the Pioneers of Aviation"; and "Hecter Fuel."

"Cabinet Maker":—"Colour and Form," by M. McLeish; "Furniture at the Canadian Industries Exhibition"; and "Students' Work at the L.C.C. Central School of Arts and Crafts."

"Chemical Age":—"The World's Nitrogen Resources," by Dr. Donnan; "Oil Resources of the British Empire," by Sir John Cadman; and "Profiteering in Soda Ash: Full Reports of Tribunal Cases."

"Fruit Grower":—"Improvement of West Country Orchards"; "Disappointing Crop Prospects"; and "Swanley Horticultural College for Women."

"Hardware Trade Journal":—"The Ideal Hardware Premises"; "Co-operative Fallacies"; and "The Ventilation of Factories and Workshops."

"Ways and Means":—"The New Outlook in Industry," by W. Peter Rylands; "By-Products and Economy," by S. Howard Withey; and "The Servant Problem: A New Aspect," by Miss Mabel B. Willison.

"Gas World":—"Manufacture of Neutral Sulphate of Ammonia," by J. T. Sheard; "Withdrawal of the Household Fuel and Lighting Order"; and "An Association of Technical Gas Officials."

Forty Years Ago.

(THE ELECTRICIAN, JUNE 12, 1880.)

THE TELEPHONE IN BELGIUM. An experimental trial of the Bell telephone between the Hotel Communal and the fire station at Liège has been, says the "Indépendence Belge," so successful that a network of lines will, no doubt, be established for the public service, and will be augmented by private enterprise.

JOURNAL OF THE SOCIETY OF TELEGRAPH ENGINEERS.—The current number contains some interesting information concerning the extent of the use of the Jablochkoff light. According to M. Besly, a total of 1,716 lights are in use, of which 465 are in Paris, 428 in the French Provinces, 198 in England, the remainder in various other countries. In this number will be found Papers on effects produced by "The Immersion of Steel and Iron Wires in Acidulated Water," by Prof. Hughes, and "On the Adhesion of Metals Produced by Currents of Electricity," by Mr. Strol.

ELECTRIC LIGHTS IN BUOYS.—"The whistling buoys now in use weigh about 15 tons each, and in their plunging, even during calm weather, a force of nearly 3 H.P. is evolved. To utilise this waste energy Mr. Edison has devised a small dynamo machine, to be carried by the buoy, the current from which will sustain an electric light equal to one gas jet. If successful, these self-illuminating buoys must be of great use to mariners." We quote the above from our contemporary, the "Scientific American," which, however, gives no explanation as to *how* its energy is to be utilised. Ideas of this kind are cheap, but the means of carrying them out are by no means so easily hit upon.

EXPERIMENTS IN MAGNETISM.—An interesting experiment in magnetism has been described to the French Academy by M. Obalski. Two magnetic needles are suspended by five threads attached to unlike poles over water in a vessel. Their distance from each other is a little greater than the sum of their radii of mutual attraction, and their poles are opposite each other. The water is gradually brought up over them by means of the tube of caoutchouc connected with the vessel, and wound on a drum. When immersion commences the needles approach each other by their immersed parts, and when the immersion has reached the third or fourth of the needle's length they go together. The explanation seems to be that what hindered the approximation of the needles was their own weight, and the force of gravity being weakened by the immersion the magnetic forces become manifest. A corresponding, though opposite, phenomena is witnessed when the needles are suspended by their poles of the same name.

Arrangements for the Week.

FRIDAY, June 11th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers on "Radiation and Convection from Heated Surfaces," by Dr. T. Barratt and Mr. A. J. Scott, B.Sc.; "An Electrical Hot-Wire Inclinometer," by Mr. J. S. G. Thomas, M.Sc.; "Convective Cooling and the Theory of Dimensions," by Mr. L. F. Richardson; and "The Radiation from a Perfectly Diffusing Circular Disc," by Mr. J. W. T. Walsh, M.Sc.

MONDAY, June 14th.

FARADAY SOCIETY.

8 p.m. At the Chemical Society, Burlington House, Piccadilly, W. Papers to be read: "Conduction of Electricity through Fused Sodium Hydrate," by Dr. A. Fleck and Mr. T. Wallace; "The Measurement of Electrolytic Resistance using Alternating Currents," by Dr. H. F. Haworth; "The Measurement of Electrical Conductivity in Metals and Alloys at High Temperatures," by Mr. J. L. Haughton; "The Theory of Electrochemical Chlorates and Perchlorate Formation," by Messrs. N. V. S. Knibbs and H. Palfreeman; "The Sorption of Iodine by Carbon," by Mr. J. B. Firth; "The Electrolysis of Solutions of Sodium Nitrate using a Copper Anode," by Mr. F. H. Jeffery, M.A., "The Pressure Variation of the Equilibrium Constant in Dilute Solution," by Dr. A. M. Williams, and Description of Models Illustrating Crystalline Form and Symmetry, by Miss Mina Hosali.

WEDNESDAY, June 16th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Discussion on Sir Dugald Clerk's Paper entitled "Distribution of Heat, Light and Motive Power by Gas and Electricity," and on the Report on the Coal-Gas and Electrical Supply Industries of the United Kingdom to the President of the Institution of Gas Engineers, by Sir Dugald Clerk, K.B.E., F.R.S., Prof. A. Smithells, C.M.G., F.R.S., and Prof. J. W. Cobb, C.B.E.

The Editorial, Advertisement and Publishing Offices of "THE ELECTRICIAN" *are at* 8, *Bouverie Street, London, E.C.*4. *Telegrams: Benbrotric, Fleet, London. Telephone: City* 9853 (4 *lines*).

The subscription to "THE ELECTRICIAN" *is* £2. 12. 0. *per annum in the United Kingdom, and* £2. 14. 0. *per annum Abroad. Advertisement Rates can be obtained on application to the Manager. Advertisement copy and blocks should be received on the Friday preceding date of publication.*

THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE

ESTABLISHED 1861.

No. 2,196. [Vol. LXXXIV. No. 25.] FRIDAY, JUNE 18, 1920. PRICE ONE SHILLING. *By Post, 1s. 1d. Abroad 1s. 2d.*

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Notes.

The I.M.E.A. Convention.

A catalogue *raisonné* may be defined as one in which the contents of the books in a collection are exposed and criticised in such a way that the prospective buyer can see what he is likely to get, which is not always possible from the title. From this point of view, this week's issue of The Electrician may be said to be such a catalogue of next week's I.M.E.A. Convention. In another column we set out the programme in full, and the articles, generally, are such as those visiting Bradford and Ilkley will find of special interest. Besides describing the Bradford electricity undertaking, we also deal with the other works which will be open during the Convention, the Phœnix works of the English Electric Company being the sole exception. In this way our readers will be able to study, beforehand, the details of what is going to be seen, and be prepared for the recognition of items that particularly appeal to them. Preliminary information of this kind makes such visits not only more interesting, but also more profitable.

The Bradford Electricity Undertaking.

On another page of this issue we describe the recent extensions which have been made to the Bradford electricity undertaking. This article, read in conjunction with a much longer account which we gave in The Electrician of October 11, 1912, is more than an interesting epitome of that chapter of electrical history which will deal with electricity supply undertakings owned by municipal authorities. Bradford was one of the first provincial cities to have an electricity supply. Here were subsequently employed vertical turbo-alternators with an output of 3,000 kw. to economise floor space, an experiment which, in spite of pessimists, was amply justified last winter, when these sets (to use an Irishism) were normally overloaded. Bradford was one of the first electricity undertakings to realise that if the public is to use electricity in the way we want it used—*i.e.*, abundantly—it must first be cheap, and it therefore early qualified for the membership of that select society the "Point Fives," now, alas! suffering an eclipse which we feel sure is only temporary. These three points indicate that, in the best sense, Bradford has had a past. If it is having a somewhat troublous present, that is one of the conditions which are inevitable, and must be accepted, philosophically, as a sign of development. For ourselves, we have no doubt that with Mr. Roles' skill and enterprise to guide it, the undertaking will undoubtedly have a future of the brightest.

Pother at Newport (Mon.).

When in 1913 the Electricity Committee of the Newport (Mon.) Corporation purchased a 3,000 kw. turbo-alternator from the A.E.G. the agonised protests of the ultra-patriotic could be heard from Scapa Flow to Land's End. The set, however, was bought in open competition, the price quoted was far below any British tender, the steam consumption was slightly better than the British figure, and the delivery very much better than those given by any British contractor. Perhaps had the Committee been Druids, or otherwise gifted with second sight, they would have behaved differently; but, as they were only ordinary people, they did what they honestly thought was the best for their undertaking. Many people will regret to hear that, from the engineering point of view, they were quite justified, for the plant ran throughout the war without any trouble which could be laid at the doors of its designers or manufacturers. But a couple of months ago it was found an earth had developed on the rotor, and practically every British company of repute was approached to do the work of repair; but they all with one accord began to make excuse. Now Newport, like many another station at the present time, is short of plant, and to spare the machine for any length of time would have been impossible. Mr. Nichols Moore therefore advised the Committee to order a new rotor from the A.E.G., who, incidentally, promise delivery in six months at a price which no British firm in these times seems likely to be able to entertain. This price, it is interesting to note, is £1,000, and the rate of exchange 200 marks to the pound. And, needless to say, the protests of the patriotic are now not only agonised, but strident.

The Remedy.

Now we have no love for Germans as such, or for German engineering practice, or for German commercial methods; but we urge those who are upset by what has occurred at Newport to apply the Chestertonian method, and look at the matter upside down. Mr. Nichols Moore is veritably on the horns of a dilemma. He must either get this rotor repaired or restrict his supply, and so restrict production at a time when increased output is a crying need. British manufacturers apparently cannot help him, and it does not take a Solomon to guess the reason why. He therefore turns to those who can and a regrettable necessity it is that he should have to do so; and that those who can help him are Germans. There is an obvious lesson in all this which our manufacturers and workers will, we hope, not neglect to learn. We must discard politics and sport and talk; and turn to real hard work. Then such incidents will not occur. There is not, or should not be, any sentiment in business, and it is abundantly certain that if this sort of thing goes on there will be nothing in business for any of us.

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Supply Agreements.

With the increasing development of linking-up, and the tendency to concentrate the generation of electricity in large stations serving wide areas, we may in future expect to see a movement towards the standardisation of supply voltages, frequencies and even tariffs. According to Prof. Wm. Cramp, this tendency might well be extended to the agreements between the various supply authorities and their consumers. In an article which we publish on another page of this issue he criticises the lack of uniformity in present-day agreements, and the consequent unfairness to the consumers which arise therefrom. His criticism will be read with interest, if not with unwrung withers, by most station engineers. The first important question dealt with is that hardy annual the "really scientific" tariff; but as a Paper covering a portion at least of this field is being read by Mr. J. W. Beauchamp at the I.M.E.A. Convention next week, we shall defer our own comments on Prof. Cramp's views on this subject until after that event. Suffice it to say that these views in themselves provide plenty of scope for a counter attack. Another important point is the one-sidedness of many agreements on the question of availability of supply. In these days of labour troubles, the supply authority seems adequately protected against troubles rising from inability to supply, but we agree that it is only fair that the minimum charge imposable on a consumer should be waived if his workpeople desert him, and the same reasoning applies where the supply authority has, owing to a breakdown, to reduce energy available to each consumer. In such a case the consumer at least requires assurance that he will receive his share of what supply is available.

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Defects of the Minimum Clause.

The minimum payment clause has long been the cause of much heart-burning. As at present drawn, it not only gives rise to a sense of injustice in the breast of the consumer, but is a direct incitement to waste, at a time when economy is a necessity. Even station engineers see its defects, and it is often allowed to remain inoperative. Some such clause, however, is necessary, at least on paper, to recoup the supply authority for the standing charges incurred on account of a particular consumer, and we agree with Prof. Cramp that, this being the case, the minimum charge should take the form of a financial guarantee, rather than depend directly on the number of units consumed. We cannot expect station engineers to see eye to eye with Prof. Cramp in all his strictures upon their business methods, but we think those who are progressive among them will realise that certain undoubted discrepancies and injustices which now exist might well be altered, and that it will be in their own best interests to bring about those alterations among themselves. The Convention next week should form an excellent opportunity for informal conversations on this subject, and we should like to see some constructive criticisms made during the discussion on Mr. Beauchamp's Paper, although this refers more particularly to the domestic side of the question where the agreements can generally take a simpler form.

The Law of Smoke Nuisance.

The result of the action brought against the Metropolitan Borough Council of Stepney by a resident in the vicinity of the Limehouse generating station is an unpleasant reminder to engineers and managers of electricity works in urban areas that the law relating to electricity supply is not in as satisfactory a condition as they could wish or as public requirements demand. The old and much-debated point as to the extent of the liability of electrical undertakers for a nuisance has been revived after a lapse of five years. As things stand at present, an action will lie against the owners of any generating station established under a Provisional Order, granted under the Electric Lighting Acts, 1882 to 1909, for any nuisance caused by vibration or noise, the emission of grit, black smoke, &c. Prior to 1889 a special clause in each order, and since that year Sec. 81 of the Electric Lighting (Clauses) Act, provided that undertakers should not be exempt "from any indictment, action or other proceedings for nuisance." On the other hand, not only are all the electric power companies which have been incorporated by special acts, with authority to acquire land compulsorily, &c., exempt from the operation of Sec. 81 of the 1889 Act, but many local authorities (including St. Pancras and Hackney Councils) and supply companies have obtained similar powers since the date of the Report of the Joint Committee which was presided over by Lord Cross in 1898. One of that Committee's recommendations was that undertakers should be granted the powers of purchasing land compulsorily for generating stations, and that in respect of such stations they should be exempted from liability for nuisance provided they were operated in a reasonable manner and without negligence—*i.e.*, the measure of liability was to be that laid down in 1878 by the House of Lords in the case of Geddis *v.* Proprietors of the Bann Reservoir.

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Necessity for Change in Law.

If it was recognised by the Joint Committee in 1898 that the advantages of a public electricity supply were such as to render further protection necessary, how much more urgent is it now, when the applications of electricity are so numerous and so varied that nearly every phase of life and every form of industrial activity would be affected by any interference with the operation of a public generating station? We think the time has come when the Electricity Commissioners should seriously consider whether all such stations should not be protected to the extent recommended by Lord Cross's Committee. Sec. 1 of the Electric Lighting Act of 1909 authorises the compulsory acquisition of land for a generation station, and by Sec. 10 of the Electricity (Supply) Act of 1919, where a joint electricity authority or authorised undertakers obtain an order to sanction the acquisition or use of land for a generating station no person "shall be entitled to restrain the use of the land for that purpose." It is possible that this may be so construed as to protect supply authorities from legal proceedings in future, but as this is somewhat doubtful, the Commissioners might introduce a more definite clause in the Bill now before Parliament.

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Interference With Electricity Supply.

We were not surprised to learn from the evidence that the principal cause of the trouble at Stepney was the inferior character of the fuel which the engineer and manager was obliged to use on account of the coal control; but, on the facts of the case and in the existing state of the law, it is probable that no other decision was possible, and the grant of an injunction was inevitable. Its operation has, however, been postponed until November 12th next, in order to give the Council an opportunity of meeting the situation. No doubt a way out of the difficulty could be found by purchasing the plaintiff's interest in the premises occupied by him; but this is usually a costly method. The prospect of any interference with the supply of electricity to about 3,500 consumers, with a motor load of over 28,000 H.P., is a very serious matter. The Limehouse station is the largest and most important industrial supply works in the East End of London, and though, when a better class of fuel is available and alterations are made in the plant, most of the causes of complaint may be removed, there will still remain some liability to be proceeded against for vibration and noise. This is not a happy situation for any supply undertaking, more particularly for one which happens to be linked up to the Hackney station, which is exempted by statute from proceedings for nuisance in the absence of negligence in working. We suggest that it is time this anomalous state of the law should be removed, and that, in the public interest, all supply authorities should be put on the same footing as the power companies.

The Engineer and Manager.

In the early days of the railway companies it was often the custom to appoint, as general manager, an ex-naval or military officer. This policy was probably dictated by the idea that, as no one knew anything about managing railways, it was better to have a man at the head of affairs who was used to dealing with men than a pure inventor, more conversant with the behaviour of machines than with that much more complicated apparatus the human element. When electricity supply undertakings first became the fashion another policy was adopted. In privately owned concerns the secretary was often the chief official, and, though in municipal undertakings the engineer nominally directed affairs, it was probably because it was thought that it was as well to have some expert on hand in case the plant broke down, and that the financial side could be adequately controlled by the usual committee. But the policy of both railway companies and electricity supply undertakings has changed in recent years. We have seen several engineers appointed general managers of our large railway companies, not solely because engineering knowledge is becoming more and more a necessary qualification for those who sit in the seats of the mighty, but because it is becoming more and more the duty of the qualified engineer to deal with human idiosyncracies and mental workings. Diplomacy and tact are the daily weapons of such men. If they fail to wield them successfully, they go but a short way on the road to high places.

Engineering and the Chief Engineer.

The same tendency, operating in a somewhat different way, is now to be found in municipal electricity supply undertakings. The chief engineer finds that he can spare less and less time to think about ways of reducing his coal consumption and to devote to the fascinating problems of how best to protect his network by complicated apparatus, for more and more of his days must be spent in deciding questions of high policy connected with linking up, with law and with finance; and that what is left has to go in what is euphemistically called "keeping on the right side of the Committee." Our present chief engineers—or, more correctly, our engineers and managers—perform their duties in a way which can only compel admiration; but, without wishing to detract, in any way, from the pleasure they may feel at their success, it should be pointed out that many of them have grown up with their undertakings, and that diplomatic knowledge, which they now possess, has been added to them bit by bit.

The Problem of Succession.

But they are not going to live for ever, and the question arises. What is being done to train their potential successors, not so much in their engineering duties, but as managers? It will not be easy to do this, for each undertaking has its own problems, with which only a man brought up on the system can satisfactorily deal. The increasing inclination of committees of many large undertakings to appoint the assistant in the chief's place when a vacancy occurs is an indication of this. Unfortunately, however good this may be for the undertaking, it is not a little disappointing to the chiefs of the smaller concerns, who see their chances of promotion blocked, and the likelihood of spending their life in their present position becoming more and more certain. It is difficult, and will be increasingly difficult, to hold the balance between these two opposing interests.

Taxation and Enterprise.

If the British Isles were the only country in the world, or if it were only bound to other communities by such lengthy ties as those which connect us to Mars or Jupiter, the results which the present heroic attempts at national debt liquidation are likely to have on international relations would be more of a personal matter than it really is. The fact that such matters as taxation are not really national, but international, is often forgotten; but an incident, to which attention is called in a recent issue of "Ways and Means," sets the whole question in its true light. "An American business man," says our contemporary, "had formed the impression that the international financial situation would be eased by the investment of American money in English industries, and he proposed to set up a small company here in order to develop a patent of which he was the owner. The scheme, which was a modest one, would have involved the investment of some £25,000, the employment of a few hundred Englishmen, and the comfort and enjoyment of some thousands of consumers. The promoter estimated that, in order to make it worth his while to start the business, he would require a profit of £2,000 a year. On going into the matter, getting out his estimates, figuring his costs and calculating results, he discovered that he would have to make a profit of no less than £12,000 in order to pay corporations tax, excess profit duty, income tax and super tax before taking back to the United States the £2,000 a year, which to him was the essence of the whole matter. He came to the conclusion that all this would mean an excessive price for the article he proposed to manufacture, that such a price would jeopardise the demand, and that the ultimate success of the enterprise was thus altogether too doubtful to justify his embarking upon it. He has, therefore, gone back to carry on the business in his own land." There may be those who will add the cynical comment that this is a good thing, but in reality it is a great pity.

Electricity Charges at Sheffield.

The man fra' Sheffield is generally credited with more than ordinary intelligence, especially when it comes to a business deal or a discussion of commercial matters; but if many more of them talk like Mr. J. G. Graves did at the City Council meeting last week they will neither be able to claim or to deserve that distinction. Like most other undertakings, the Sheffield electricity department have a different scale of charges for power and lighting consumers, and these the Electricity Committee are seeking powers to increase on a sliding scale, the lower charges being increased at a higher rate. Mr. Graves, in opposing this suggestion, contended that, as the same machinery was used for supplying all classes of consumers, they all ought to be charged at the same rate, and that while 31 years ago it was possible to obtain electric light in Bradford at 5d. a unit, the minimum nowadays in Sheffield was 6d. Mr. Graves must wake up. He does not appear to have heard that we have been at war for five years, that wages have increased, that the price of coal has gone up, and that the cost of everything else has followed suit. In spite, however, of a patient explanation by Ald. Styring of the influence of such things as demand and load factor on the cost of production, Mr. Graves had his way, and the matter was referred back. Really, it seems as if some business men discard the greater part of their intelligence when they begin to deal with municipal affairs.

The Newcomen Society.

One of these days a history of engineering is going to be written. It will not be an easy task, for the field is enormous, and the temptations to stray from the narrow path of record and comment will be correspondingly great. Even with the strictest provisions as to what may, or may not, be included, the volume of copy must be very large, and the editorial authorities will require not only an encyclopædic knowledge, but a plentiful supply of the spirit of higher criticism. Such a history, however, is in eminent need of being written. It is for this reason, and in spite of the fact that it will mean an addition to the already over-lengthy list of engineering societies, that we welcome the formation of the Newcomen Society. It has arisen from the James Watt memorial celebration last year, when steps were taken to find out if the establishment of an historical engineering society would receive sufficient support to ensure its success. This support has been forthcoming, and at a preliminary meeting held recently it was resolved that the formation of the society should be proceeded with. Its full title is " The Newcomen Society : for the Study of the History of Engineering and Technology." Its objects are to encourage the study of the history of engineering and manufacturing industries, to disseminate historical information, to collect examples, records, drawings and illustrations of engineering work, and to publish proceedings. The membership is open to both sexes, and the subscription has been tentatively fixed at one guinea. The honorary secretary is Mr. H. W. Dickinson, The Science Museum, South Kensington, London. The society should have much useful work before it, for engineering, like other branches of knowledge, can learn a great deal from history, owing to the peculiar way that our learning has of sometimes traversing ground that has been crossed before by earlier pioneers.

A " Wireless " Concert.

The experiments in wireless telephony which are being conducted by the Marconi Company received an added interest on Tuesday owing to the collaboration of Dame Melba. This famous *prima donna* sang in front of the ordinary receiving apparatus at Chelmsford, and the concert thus provided was heard by numerous specialists and amateurs within a range of 1,000 miles. A member of our staff who was " listening in " at Watford reports that the singing was extraordinarily clear, even the notes of the accompanying piano and the conversation of those in the room being heard distinctly ; but, as is usual when wireless telephony is being employed, there was difficulty with the tuning, and it was necessary to keep constantly varying the condenser. For this reason, and seeing that these concerts and conversations are followed with wide interest, it would be as well if the Marconi Company could allow more time for tuning before the actual *séance* begins. In thus bringing the possibilities of wireless telephony to the general notice, the Company are carrying out good work. There is, of course, a great deal to be done before such methods can be established on a commercial scale, but there is no reason why any time should be lost in educating the public in the progress of this new means of inter-communication.

An All-Electric Island.

On Monday next, the twenty-fifth annual convention of the Incorporated Municipal Electrical Association will open at Ilkley and Bradford, two towns which fitly illustrate in their civic ideals the two complementary objects of the gathering, namely business and pleasure. This Convention, in recent years, at any rate, has been the biggest thing of its kind which the British electrical industry can boast ; and now, after a quarter of a century's activities, there is every reason to suppose that this year's assembly will be more, rather than less, successful than its predecessors.

The Wide Appeal of the Convention.

Now, while this Convention is theoretically mainly organised in the interests of the station engineer, and he may, therefore, be forgiven for looking upon it as his affair, it really represents a gathering of all those who are interested in electricity supply—in other words, the whole electrical industry. For to it come consulting engineers, manufacturers, contractors, factors and even editors, and there are considered and discussed, unofficially, the many little problems, negligences and ignorances which go to make up the cosmos which calls itself the electrical world. The Convention is, therefore, a great power for good ; and it follows that the greater its power the greater its good. We should like to see both its power and its good increased and multiplied.

Lessons from Another Convention.

At Pasadena, California, there has recently been held the Annual Convention of the National Electric Light Association of America. To this gathering come, not as visitors or guests, but by right of membership, representatives of all branches of the electrical industry ; and there are discussed all the troubles which beset the American electrical engineer. There is a good deal of noise and not a little spread-eagleism, but, at the back of it all, are the splendid ideas that electricity is the only thing that matters ; and that, in America, the National Electric Light Association are the only people who matter. So much noise does the Association make about its Convention and so convinced are they of the rightness of their case that they have attracted the attention of the political element and the Governor of California became so far interested in their work to announce that the Californians realised " the need of electrical development."

A Lesson in Combination.

Now, if there is one thing that we do not desire to do it is to make comparisons unfavourable to ourselves between what is being done in the United States and in this country. Conditions over there are not our conditions, and their methods are not our methods. A vast amount of noise does not always mean a corresponding amount of work, and with our unorganised ways we sometimes achieve better and more lasting results than do those whose methods would give, superficially, the impression of greater progress.

Nevertheless, there is one lesson which we can learn, and should apply, from the activities of the National Electric Light Association. That lesson is combination, for therein lies strength. At present the energies of supply engineers are too much frittered away in sectional activities. Each little group has its own Association working its own little field and eyeing, with distrustful, if not hostile, glances what every other little group is doing. If an advance is made by one group and results in a temporary set-back there is unholy joy on the part of the other groups, while each one works for his own ends rather than for the good of the electrical industry as a whole. So much is this so that there are even some municipal electrical engineers who do not belong to the I.M.E.A.

A Linking Up of Effort.

Such a policy is going to do no one any permanent good. Parochialism must be replaced by Nationalism, and linking-up must not be confined to electricity supply systems, but be extended to the work of educating the public. We feel sure that the Electricity (Supply) Act is going to do great things for the electrical industry, but one thing it cannot do is to provide a substitute for personal effort when that effort is properly applied. By proper application we mean employing all our energies in the best possible way to increase the use of electricity on the broadest basis rather than to expend it more or less inefficiently in sectional endeavours. There never has been such a chance to do this as the present. High labour costs, real desire for more efficient work and a need for specialisation, are turning manufacturers more and more to the use of electric power. The servant difficulty, greater artistic perceptions and a desire for more comfort, will increase the use of electricity in the home. In the field of ordinary and display lighting, in electric traction, in agriculture, in the textile industry, in metallurgical works, in materials handling, there is nothing but progress to report. An "all-electric" island need be no dream, but an early future reality, if, by combination, the electrical industry will turn to and make a right use of its forces.

Recent Progress in Thermo-Electricity.

The Institute of Metals is to be congratulated on the uniform excellence of the May lecture which is delivered annually to its members. The 1920 lecture, the tenth, was delivered last Thursday evening, by Prof. C. A. F. Benedicks, of Stockholm University, the subject being "Recent Progress in Thermo-Electricity." The lecture, which was delivered in English and illustrated by experiments, was of the greatest interest, and should appeal particularly to electrical men.

Thermo-electricity is a decidedly fascinating branch of electrical study even though, or it may be because, most of us remember the struggle which we had in our student days to sort out the Seebeck, Cumming, Peltier, Thomson and Joule effects from one another. Somehow the Peltier and the Thomson effects seemed to be so elusive, and even when we had mastered the Peltier effect—as we had to master it if we were to understand why thermal energy was necessary to maintain a difference of temperature between the hot and cold junctions—the Thomson effect still remained to worry us. And now another effect has been added to the last.

"The Benedicks Effect."

Just as the Peltier effect may be regarded as the converse of the Seebeck effect so may this new effect—which as Prof. Benedicks ingenuously said: "May be associated with the name of the lecturer"—be regarded as the converse of the Thomson effect.

Perhaps we may be permitted to remind those of our readers who have not had much opportunity of keeping this branch of the subject before them that the Thomson effect stated broadly is this: That a current of electricity flowing in a metallic conductor one part of which is at a higher temperature than another will produce a "current of heat"—*i.e.*, a transference of heat. If the conductor be of copper and a current flows from the hot portion to the cold portion heat will apparently be transferred so that the hot portion will tend to be cooled whilst the cold portion will tend to be warmed; whilst if the current flows from the cold portion to the hot portion heat will be transferred "against" the current. In the case of iron on the other hand the direction of heat transference is against the current when it flows from hot to cold and with it when it flows from cold to hot. In the case of lead no Thomson effect has been observed.

A Converse of the Thomson Effect.

Prof. Benedicks effect—which he dates from 1916—is the converse of the Thomson effect. If a metallic conductor (one metal only) has one portion heated above the temperature of another portion a current of electricity may be set up and its direction will be such that by the Thomson effect it will tend to equalise the temperature of the two portions. Thus in copper the current set up will tend to flow from the hot to the cold portions, whilst in iron it will tend to flow from the cold to the hot.

A Simple Discovery.

This effect seems to be a natural corollary to the Thomson effect, so much so indeed that instead of giving immediate credit to Prof. Benedicks for his discovery we found ourselves wondering why it had not been discovered before. The credit to the discoverer is all the greater; for whilst many investigators must have tried to find some such effect, in view of the general reversibility of electrical effects, he has succeeded where the others have failed. In demonstrating experimentally this effect at the lecture he revealed the principal conditions necessary to obtain observable results. The main point is that a very sharp temperature gradient between the hot and cold portions of the metals is essential, and he showed two methods which he had used to obtain this. The first was by making a short and narrow constriction in the conductor and raising the temperature on one side of this constriction by means of a very neat little point flame. The second was by the simple plan of crossing two pieces wire of the metal—having the usual circular section—so that contact between them was practically point contact. If, for example, the ends of a coil of wire be crossed over one another, like an X, and one wire be heated with this needle point flame at a position close to the junction a current will be set up in one direction round the coil, whilst if the other wire be treated similarly the current will be set up in the reverse direction. The direction of the current depends upon which side of the point of contact (or constriction) is heated, and, of course, upon the material of the crossed or constricted wires. Naturally a very sensitive galvanometer is necessary.

A Thermo-Electric Motor.

Another interesting experiment consisted in suspending a thin copper plate of rectangular form, in a vertical plane, so that it was parallel to the lines of force of a horse-shoe magnet, and capable of rotation about a vertical axis. It was provided with a mirror and used like a reflecting galvanometer. When, say, the top right hand edge of the plate was heated with the point flame a deflection was produced, this being reversed when the bottom edge was heated, suggesting that thermo-electric eddy currents were set up in the plate. On this principle we were shown a small thermo-electric motor—the *pièce de resistance* of the experimental demonstrations.

Prof. Benedicks described amongst other things some experiments which he had carried out in comparing thermal and electrical conductivities. Given two conducting paths of equal length of the same metal and of the same *electrical* conductivity, the only difference between the two paths being that one was solid or nearly solid, whilst the other was stranded or divided into parallel paths, Prof. Benedicks stated that the thermal conductivity of the more "solid" path was always better than that of the "divided" path. These experiments are leading up to some interesting speculations on the question of thermal and electrical conductivity.

Agreements for the Supply of Electrical Energy to Works.

By Prof. WILLIAM CRAMP, D.Sc., M.I.E.E.

If supply authorities are to give supplies of electricity at the lowest possible rates, it is necessary that there should be some certainty as to the call that can be made upon them, and as to their minimum return in the form of income from kelvins sold. In other words, the element of speculation must as far as possible be eliminated. This is the object of the agreements into which large consumers are asked to enter when negotiating for a supply to their premises. Such agreements besides setting forth the price at which the supply will be given, also contain a series of clauses determining the conditions under which the authority will supply, and the consumer will use, the energy. The writer has negotiated many such agreements, and is surprised at the diversity in form, and the variation in detail as between different undertakings.

It would seem to be desirable, especially in view of the National Control of electricity supply, that some standard form of agreement should be arrived at which would fairly protect both parties. In general, the agreement is formulated by the supply authority, under the advice of their solicitor and their engineer; so that it is not surprising to find that the protection of their interests is amply provided for. The consumer, on the other hand, often lacks expert knowledge of the commodity he is about to buy, and in addition he has little definite information as to the conditions under which the energy can best be used. Terms such as "load factor," "diversity factor," "power factor," "K.V.A." "maximum demand," &c., mean little or nothing to him, and he is rarely capable of determining whether the premises will be best driven by one or two, or a large number of motors. His interests, therefore, are quite often inadequately safeguarded; a fact which he gradually recognises as his experience grows.

To popularise and to explain by means of public lectures some of these matters might well be a function of the Institution of Electrical Engineers. Besides this the Institution might draw up a series of standard clauses to form the basis of an agreement for energy much as the standard general conditions of contract have been evolved. But it would be necessary that that work should be thoroughly impartial, a consummation hardly arrived at in the General Conditions of Contract.

System and Capacity.

The first important clause, after a general preamble setting forth the parties to the contract, would be that defining the system of supply, the declared pressure, and the capacity of the installation. Under this clause the permissible variations in the pressure should be specifically stated, and the consumer would do well to watch that these, except in special circumstances, do not exceed the Board of Trade limits. Here also the purposes for which the supply may be used often appear, and since the standard rate suggested later is on the maximum demand system consumers should see to it that lighting is not denied them. What justification supply authorities can have for a different rate for lighting it is impossible to understand, but the fact remains that the use of the power supply for lighting purposes is often refused.

The "capacity" of the installation as defined in this clause is a very important figure, since, on the one hand, it limits the power which the consumers may demand, and on the other, the plant which the supply authority must keep constantly available. Also, if the writer's suggestion of adopting this as the basis of the maximum demand be adopted, it becomes still more important; and a provision must be inserted for varying it from time to time.

Price of Energy.

The next clause might define the price to be paid for energy. Here we are faced with historical and technical difficulties which have led to the invention of a thousand methods of charging. All of these should be swept away in favour of a tariff resting upon the basis of the cost of supply.

Now the cost of supplying energy may be roughly analysed into two parts. The first part is due to the provision of means to supply, and depends chiefly upon the maximum power promised at call, and the geographical position of the consumer with reference to the generating station. It is therefore handed on to the consumer in the form of a charge per kw. demanded per annum, and is often referred to as the *fixed charge*. The other part is dependent upon the cost of generating the energy actually supplied, and upon the losses incurred in the transmission. It is usually handed on to the consumer in the form of a charge per kelvin; and as such may be compared with a supply of gas of declared calorific value per cubic foot at a declared pressure. It is called the *running charge*. Thus arises the compound charge which is now generally and rightly adopted for power consumers, but which should be applied to *all* consumers.

Typical Compound Charge.

Since the running charge depends largely upon the price of fuel, a correction for variations in this factor is usually introduced. Indeed, some central station engineers argue that fuel alone should determine the running charge. The following form might well serve as the basis of a standard clause.

"A charge of £n per quarter per kw. of maximum demand plus m pence per kelvin registered by meter. The price charged to the consumer per kelvin to be increased or decreased p pence per kelvin for each complete shilling rise or fall in the price of coal from the basis price of q shillings per ton." This rate is subject to the signing of an agreement for a number of years involving a minimum annual payment.

Unaccountable Differences.

So far as is possible, to keep industry upon a uniform basis, it is clear that throughout Great Britain the constant n, m, p, q, in the compound charge should not vary. Unfortunately, the electricity undertakings in this country have been founded, built up, and run in such a variety of ways that the most unaccountable differences exist between different towns, even when similarly situated. It is, however, clear that some variations are justifiable and to be expected. For instance, as between two consumers in the same town, the tariff might be lower to him whose works are nearer to the generating station, and whose demand comes at a time when most other consumers are taking but little energy. In addition, the fixed part of the charge may be lower to the consumer whose maximum is large, since the cost of plant is less than proportional to its rated capacity. Notwithstanding these obvious contentions it is seldom that supply authorities will thus distinguish between different consumers.

Differences in Different Towns.

Again, as between towns the fixed charge should be lower in the larger and more concentrated areas, especially if too much money has not been spent upon terra-cotta and white tiles, and similarly the running charge should be lower when the town is large and concentrated, and especially if it be near a coalfield. In practice, however, these justifiable variations do not often appear. For example, we find the fixed charge higher in Liverpool and in Manchester than in Rochdale or in Sheffield, while the running charge is higher in Rochdale than in Liverpool and (we believe) in Bristol.

Kw. or K.V.A. Maximum Demand.

Again, of supply authorities having alternating current systems some will charge per kilowatt of maximum demand; some per kilovolt ampere. And there are similar discrepancies even in definition and measurement of the maximum demand, some taking a 20 minutes time average, some allowing half an hour, and yet others inciting to dishonesty, base the demand upon the name-plate figures of the motors.

It will be seen later that under the "availability of supply" clause the supply authority is bound to keep constantly available the power which the consumers require up to a certain total capacity. Now this capacity should really define the maximum demand. For it represents the plant (and hence also the capital expenditure) which the supply authority promises to hold always at the disposal of the consumers. From this strictly equitable point of view the maximum demand should be a figure agreed on from time to time, and not a variable M.D. meter reading. This no doubt is the argument in favour of basing the M.D. upon the name-plate horse-power of the motors installed. The principle seems just, but the basis is unsatisfactory for reasons already given. Also the various M.D.'s on the mains, do not occur simultaneously, so that through their diversity the supply authority stands to gain, and consumers dislike paying on the basis of an M.D., which they may not reach. As a compromise the M.D. meter has been introduced and seems likely to remain, but to the writer it does not seem to be just. He recommends that an agreed maximum demand should appear in the agreement, and that an M.D. meter should be used merely to prove that this maximum is not exceeded. He has negotiated agreements on this basis with satisfaction to both sides, and it is clear that such an arrangement meets the object of the M.D. clause. Incidentally a figure agreed to in this way abolishes the tendency of the consumer to avoid the increase of his plant near the end of his accounts period; and thus gives him more liberty. Of course, on such a basis the price per kilowatt of M.D. should take into consideration the advantage to the supply authority due to the diversity factor.

Freak Tariffs.

Apart altogether, however, from these expected and unexpected variations, there exists in Great Britain a number of freak tariffs which no man can explain. In the north of England, for instance, there are at least two cases in which the fixed charge falls—not continuously but in jumps, as the maximum demand rises. Since the running charge is in these towns constant, we find that a consumer may sometimes reduce his average price per unit by making his load factor worse. In one tariff beyond a certain maximum demand the fixed charge suddenly jumps up to almost twice its previous value, the running charge at the same time being considerably reduced. In this case two consumers whose load factors are 30 per cent. and 50 per cent. respectively, pay the same average price per unit although their maximum demands are nearly identical.

The Abolition of Secret Agreements.

Many other absurdities might be quoted if the writer were at liberty to do so. But, unfortunately, there are still many supply authorities whose agreements are kept secret, and information acquired professionally of such arrangements cannot be divulged. The practise of adopting secrecy in these matters is really indefensible and should be abolished. In one large town, for instance, should the expenses of the Corporation overstep the limit of decency to the extent of a few guineas, a watchful citizen auditor will comment upon the matter in the columns of the "City News." But should some favoured consumer be granted an agreement for power on terms out of all comparison with those allowed to fellow citizens, no ordinary ratepayer (though really a shareholder in the undertaking) is allowed to know of the fact. It is easy to see to what doubtful practices such secrecy might give rise, and there is always the risk of creating an atmosphere of suspicion among the various classes of consumers. The writer, therefore, advocates most strongly a clause such as is outlined above, and the entire abolition of secret agreements.

The Right to Strike.

It may be necessary, now that the cost of all commodities is regulated by labour's unfettered right to strike, to embody a clause covering the supply authority when wages rise, but this should certainly carry with it a corresponding concession to the consumer when the cost of labour per kelvin falls. In other words, the clause should, like the coal increment, be based on the cost of labour per kelvin, and not directly upon changes in the rate of wages.

To illustrate the unwarranted discrepancies in the factors of the typical compound charge it can be shown that in parts of the country similarly situated, for *the same load* the value of n varies from £2 10s. per kilowatt per annum up to £6 per kilowatt per annum. Similarly, the value of m will be found for the same class of load to vary from 0·25d. to 0·6d. The coal increment, however, is fairly steady at 0·02d. to 0·03d. per kelvin for each shilling increase in the price of coal above the basis price, which varies from 10s. per ton to 18s. per ton. Now, since n depends on capital cost of plant only, it should surely be almost the same throughout the country *for the same demand*. The value of m of course will vary with the station situation and with its load factor, but not to the extent quoted. No clause is yet available to cover the variable labour cost, but as the cost of labour per kelvin is of the order 0·1d. to 0·3d. per unit for well managed undertakings it is clear that an addition to the standard clause somewhat as follows might cover both parties.

"The price to be charged to the consumer per kelvin to be increased or decreased by 0·075d. for each tenth of a penny by which the labour costs shall vary from the basis rate of s pence per kelvin." Here s is the cost of labour per kelvin at the time of signing the agreement; or at some time when the figure was regarded as practically constant.

Miscellaneous Clauses.

Next may follow a number of clauses calling for little comment and covering the following points:—

Meter Clause defining the method of metering, whether on the high tension or low tension side; the method of testing the meters and the limits of accuracy; the consumers right to demand a test; and the testing authority.

Converting Plant and Sub-Station Clause.—Defining the provision and ownership and insurance of these items and of the cables connected thereto.

Accounts Clause.—Defining the period and payment of accounts, the correction for faulty meters, the discounts for cash and interest on overdue accounts.

Interference with Supply Clause setting forth those parts of the installation with which the consumer may not interfere.

Inspection Clause, giving to the supply authority the right to enter for inspection, and to take reasonable tests for leakage at all times except such as are specially inconvenient to the consumer. For instance, a test involving the stoppage of important processes should not be allowed unless urgently necessary, and entrance to a works outside reasonable hours should also be refused.

Termination Clause defining the period of the agreement, the notice required for termination and the automatic renewal period. It is often useful here to give the consumer the right to terminate the agreement before the expiry of the period on payment of a fine. This fine might be arrived at by computing the loss of profit to the supply authority on the basis of the minimum consumption. But the amount should be clearly stated. As regards period, five years with the right to terminate at the end of three years is the shortest period that can be expected; but seven years with the right to terminate at the end of five years is quite reasonable.

The notice to be given should be at least three months, but better six months, and the clause should state that if notice is not given by a certain day in the year of the termination, the agreement automatically continues for another year.

Arbitration Clause providing for arbitration without counsel in the case of any dispute. The arbitrator to be the President of the Institution of Electrical Engineers for the time being or his nominee.

Consumers of like Demand Clause. This is often introduced, and provides that consumers of like demand shall be similarly treated. It is, however, as usually worded quite useless for two reasons. In the first place the protection afforded is only that already given by Act of Parliament, and in the second place this protection is quite illusory. For "like demand" has been held to include the amount of energy consumed, the expense of supplying it, the uniformity of demand and the time at which the energy is required. It is impossible to imagine two consumers similar in all four items; so that as so often happens—a protection intended no doubt to be real by the House of Commons—has been taken away by the courts. But besides this the only party having the records to prove such a similarity is the supply authority, and the writer knows of no right on the part of the consumer whereby he can force the authority to disclose the records short of a difficult and very expensive lawsuit.

Availability of Supply.

In addition to these clauses there are certain matters of great importance to the consumer which require special consideration. Of these, the first is that relating to the hours during which the energy shall be supplied.

Since by the Board of Trade regulation, the supply must be available whenever the consumer may require it, it is reasonable to limit the liability of the supply authority by stipulating in the agreement the maximum power which he shall be called upon to furnish; and this is done under the "capacity of the installation." It is also reasonable that the supply authority should be protected against the operation of this liability if "*force majeure*" should render continuity of supply impossible. Such contingencies as fire, strikes, accidents are in this sense intended to be included under the term "*force majeure*," although it is quite usual to mention them separately. Lock-outs are also frequently mentioned, but the justification for this does not seem to be so obvious since a lock-out implies that the initiative is on the side of the management. However, by such provisions the supply authority's interest is usually well protected. On the other hand, the inconvenience and loss which the consumer will suffer is generally forgotten altogether. If the supply authorities are not to be held liable for causes over which they have no control it is at least only fair that the consumer should be allowed some rebate on account of energy which he might have used had it been available.

Serious Partial Disablement.

Again, in the case of a serious partial disablement of the electricity supply machinery, it may be necessary for the supply authority to reduce for a considerable period the output of the station. Several cases of this kind have happened recently, and in some instances the engineer to the undertaking could hardly be held blameless. The consumer ought to know exactly how he stands in such a case. Agreements should be so drawn as to minimise as far as possible the loss occurring to all consumers, and care should be taken that no individuals are specially favoured in the subdivision of the available power. In the opinion of the writer the public services, such as street lighting and tram cars have the first claim, after that come consumers whose processes must run continuously, such as chemical works, and finally, the intermittent consumer of lighting alone. It would, in fact, be fair in most cases to divide the reduced supply in proportion to the load factor of the consumers.

A Safeguard Clause.

The following typical clause will illustrate the manner in which these safeguards may be introduced. "The supply authority shall keep constantly available all the power which the consumers require up to their total capacity as stated in clause — unless they shall be prevented from so doing by *force majeure*, accident or strike, provided always that in the event of the supply authority being unable to supply the requirements of the consumers up to the total capacity of their installation, then for each week during which the authority shall so fail, they shall allow to the consumers a rebate from their minimum consumption equal to the number of kelvins by which the supply has fallen short of the minimum, provided also that any alteration to the price per kelvin paid by the consumers due to the reduction of supply shall not operate, but that the price to be charged shall be the same as if the consumers had run throughout the period with their normal load factor. Should the supply authority be compelled by *force majeure*, accident or strike to reduce or suspend entirely for a period exceeding one day, the normal total output of their generating plant, the energy available shall be shared among the consumers in proportion to their load factors except where the supply is required for public services, or where the loss of life, the flooding of a mine or destruction of property is at risk."

Minimum Clause.

In order that the supply authority may have some guarantee as to the continuity of demand to compensate them for expenditure upon plant, it is necessary to introduce a clause under which a consumer is bound to pay for a certain quantity of energy per annum, whether he actually takes it or not. The proportion which this minimum should bear to the kelvins that would be consumed if the consumer's load factor were unity is a subject of much dispute. Theoretically the only just claim which the supply authority has, is in respect of standing charges, and from this point of view it would be fair to base the minimum payment upon the consumer's maximum demand, and upon his distance from the generating station. There is no reason why this minimum should be in the form of a number of kelvins at all. It would be better and fairer to express it in the form of a minimum annual sum of money, and this should be arrived at by estimating the value of the plant which the supply authority keeps available for the consumer and by allowing a fair rate of interest and depreciation upon it. In the writer's opinion 20 per cent. is a reasonable rate, which will allow for standing charges not usually included under interest or depreciation, but which cannot be reduced by the supply authority at will. The practice of expressing the minimum in terms of energy has the most undesirable effect, of causing the consumer to try to consume the energy faster when he is getting near his minimum, even if to do so he has to waste it.

It is a psychological fact that there are few things which a man dislikes more than to be obliged to pay for something which he does not use, whereas in this case it is certainly to the advantage of the community that as little energy as is consistent with efficiency should be used in any given process.

Two Important Questions.

Two other important questions arise in the minimum clause. The first is the protection of the consumer if he should by "*force majeure*" be compelled to reduce for a considerable period the working of his business. This is really the companion clause to that protecting the authority in the case of availability of supply. The second is the protection of the consumer if he should be obliged by "*force majeure*" to close his works altogether.

As regards the first, it may be remarked, that if the stoppage is for a short time only, say, two or three weeks, the supply authority has an obvious claim for income expected. But where the cause is a fire, for instance, eventuating in a stoppage for six or twelve months, the energy rendered available can often be used for other consumers. The minimum payment, therefore, may reasonably be reduced if the stoppage due to *force majeure* exceeds, say, three months, and notice is promptly given by the consumer.

The second case arises when by an accident the works is totally destroyed, and for good reason it is inexpedient to rebuild. The best way of dealing with this is to insert a provision under which the agreement may be cancelled on the payment of a reasonable fine proportionate to the unexpired term of the agreement on the one hand, and to the minimum consumption on the other. Such a clause has the double effect, by releasing both parties, of enabling the consumer to settle his affairs quickly, and of enabling the authorities to divert the supply to their waiting list without serious loss. The following words have been found satisfactory to this end:—"Should the consumers be compelled to suspend work at their premises for a period exceeding three months in consequence of a cause over which they have no control, their minimum payment for the twelve months during which such suspension occurs shall be reduced by £x per week for each week after the first six of such stoppage, provided that the consumers give notice to the supply authority within one week of the occurrence, of their intention to avail themselves of this clause.

"Should the works of the consumers be disabled by accident, fire, flood, tempest or any cause over which they have no control, and should the consumers in consequence decide not again to reconstruct the works or to carry on the business in those premises, this agreement may be cancelled by giving to the supply authority one months' notice in writing, accompanied by a cash payment at the rate of £y for each unexpired year of this agreement."

As to the amounts to be inserted for x and y above, it is suggested that the rate per week x, might be 1 per cent. of the minimum annual payment; and that the payment y might be 50 per cent. of the annual minimum.

Conclusions.

Enough has been said to show the necessity for some standard form of agreement for power consumers, and to indicate the lines upon which it might be drawn up. It has been suggested also that the I.E.E. might well take the initiative in this matter, and the writer hopes that such will be the case. More than that is needed however. The granting of secret and fantastic tariffs ought to cease, and instead some satisfactory and universal basis should be adopted. No power exists for compelling such a reform unless it lie with the Electricity Commissioners.

But supply authorities and their engineers may, with all respect, be reminded that a reform from within is far more desirable and effective than one from without. Will not the I.M.E.A. then reflect on this matter, and perhaps deal with it at their next meeting?

Electrical Developments at Bradford.

An Account of the Latest Extensions of a Progressive Undertaking.

It is a happy custom which arranges that the Annual Convention of the Incorporated Municipal Electrical Association shall be held in the town of which the president is the chief electrical engineer, and that during the Convention an opportunity should be given for the undertaking to be inspected. This allows those attending the Convention to see how the man who for the time being is the titular head of the electricity supply world performs his duties, and enables them to go away with some useful lessons stored up for future employment. From this point of view it is particularly appropriate that Bradford should be the scene of this year's Convention, as it is one of the oldest of municipal electrical ventures, and is certainly not one of the least progressive.

Historical.

A supply of electricity was given in Bradford as long ago as 1889, and during the subsequent years matters developed on so satisfactory a scale that in June, 1912, Mr. Roles the then and present chief electrical engineer and this year's President of the Convention, was among the earliest members of that very select society—the Point Fives. The attached list of a few of the largest consumers with their demands, gives some indication of the scope and variety of the power load:—

Mitchell Bros., Worsted Spinners	640 k.v.a.
Bradford Dyers' Association, Dyers	1,050 kw.
Thwaites Bros., Ltd., Engineers	3,410 k.v.a.
F. Ambler, Worsted Spinner	1,400 k.v.a.
Benson, Turner & Son, Ltd., Worsted Spinners	380 k.v.a.
H. Longbottom & Co., Ltd., Worsted Manufacturers	101 k.v.a.
J. Emsley & Company, Worsted Manufacturers	136 k.v.a.
J. Wilson, Ltd., Worsted Manufacturers	143 k.v.a.
English Electric Co., Ltd., Electrical Engineers	826 k.v.a.
Crofts (Engineers), Ltd., Engineers	463 k.v.a.
Holdsworth & Sons, Ltd., Boiler Makers	110 k.v.a.
E. Ripley & Sons, Ltd., Dyers	542 k.v.a.
Lister & Co., Ltd., Silk Manufacturers	414 k.v.a.
Valley Combing Co., Ltd., Wool Combers	130 k.v.a.
H. & J. Gaunt, Wool Combers	163 k.v.a.

The very success of electricity supply in Bradford has, however, brought with it certain disadvantages during the war years. Increasing trade and the difficulty of obtaining suitable generating plant, apart from the economical fallacies of following such a course, have led more and more manufacturers in Bradford to take a supply from the public mains, and have so increased the load that the present generating plant is only just able to cope with the demand. In addition to this, the Coal Controller has played his usual part, with the result that what with the poor quality of the fuel and the general administrative and running difficulties, the Bradford undertaking has during the past few months been in a very unenviable position, and this unenviable position has been accentuated by an unfortunate breakdown which occurred on one of the largest sets. These difficulties, we are glad to say, have now been overcome, and visitors to the Valley Road Station and its subsidiary sub-stations during the coming week will find everything in apple-pie order, and little indication of the period of strain and stress through which Mr. Roles and his assistants have been passing.

Some Recent Extensions.

In this article we shall confine ourselves to describing more particularly the extensions which have taken place at Bradford since October, 1912, on which date we dealt in considerable detail with the plant then installed.*

Steam Raising Plant.

A plan of the present arrangement at the Valley Road Station is given in Fig. 1. It will be noticed that there are two boiler houses (Nos. 2 and 3). No. 2 contains five Babcock & Wilcox boilers fitted with chain grate stokers, the evaporative capacity of each boiler being 15,000 lb. per hour when operating on natural draught. In order to increase the output of this boiler house, an induced draught plant is shortly to be installed. The fan will be of the multi-bladed pattern, made by Messrs. Musgrave & Company, the capacity of which will be 90,000 cubic ft. gas per minute. It will be direct-coupled to a 70 B.H.P. alternating-current motor. These boilers have recently been equipped with Musgrave mechanical draught equipment, details of which are given below.

No. 3 boiler house contains 10 B. & W. boilers of a similar type, each capable of evaporating 18,000 lb. of water per hour at a pressure of 180 lb. per square inch, two B. & W. boilers each of 25,000 lb. capacity fitted with superheaters for raising the temperature of the steam by 200° F., while there are also three 32,000 lb. three-drum B. & W. land type boilers. These last three boilers have a heating surface of 9,273 sq. ft., and are constructed for a daily working pressure of 200 lb. per square inch. They are fitted with integral superheaters giving a superheat of 200° F. Each boiler, as are the others in the station, is fitted with double mechanical chain grate stokers. These grates are driven by electric motors through worm reduction gear. Each boiler has three drums, is complete with steel casings, and has a mild steel uptake, which is lined with cellinsulate, to lead the gases from each boiler to the economisers, which are situated on the floor above. These boilers have an overload evaporation of 45,000 lb. under conditions mentioned above. Three more boilers of a similar capacity are on order.

Plans are now being got out to extend No. 3 boiler house on to the site now used as a "coal yard," and designs have been prepared for the erection of four boilers, each with a capacity of 65,000 lb. of water per hour.

Coal Supply.

Coal is supplied to No. 3 boiler house from overhead bunkers, having a capacity of 2,000 tons, the coal being delivered into these bunkers by means of a Goodhall-Clayton bucket elevator and push plate conveyor and a Graham-Morton elevator. When the Valley Road Station was first designed ideas on the subject of coal supply and delivery were very different from those now existing. The result is that practically all the coal therefor is road borne from the railway adjacent to the works; but the difficulties which this system imposes have been overcome in an ingenious and modern way. The railway runs parallel to the station, from which it is only separated by the road, but at a slightly higher level. A special siding has been constructed over a series of stone bays, into which a lorry can be backed and coal discharged from the trucks by gravity. Both steam and electrically-driven lorries are used. These vehicles convey the coal into the station, where it is tipped on to one or other of the conveyors. This arrangement will however, shortly be improved by the installation of a conveyor which will pass under the roadway, and enable most of this handling to be avoided.

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* *See* The Electrician, Vol. LXX., p. 8, October 11, 1912.

A Good Use for Electric Vehicles.

The electric vehicles used for this work have been entirely satisfactory, and have proved considerably more economical than the steam vehicle, owing to the shortness of the run and the consequently high proportion of standing time. These trucks are also being used for conveying material for mixing concrete for the boiler-house extensions, and we understand as much as 50 tons of concrete per day have been moved with one truck at a cost of about two shillings.

Circulating Water Arrangements.

The lack of modernity in the lay-out of Valley Road Station is also obvious when we consider the circulating water arrangements. There are four natural draught chimney coolers, made by the Davenport Engineering Company, three open-frame coolers, made by the Film Coolers, and, in course of erection, a cooling tower by Messrs. Peter Brotherhood, having a 100 ft. chimney, the capacity of which tower will be 350,000 gallons per hour. The present capacity of the cooling installation is 2,270,000 gallons per hour, and the ultimate capacity of the site approximately 3,500,000 gallons per hour under natural draught conditions. At the time of erection, one of the Davenport coolers, which has a capacity of 365,000 gallons per hour, was one of the largest, if not the largest, that had been constructed.

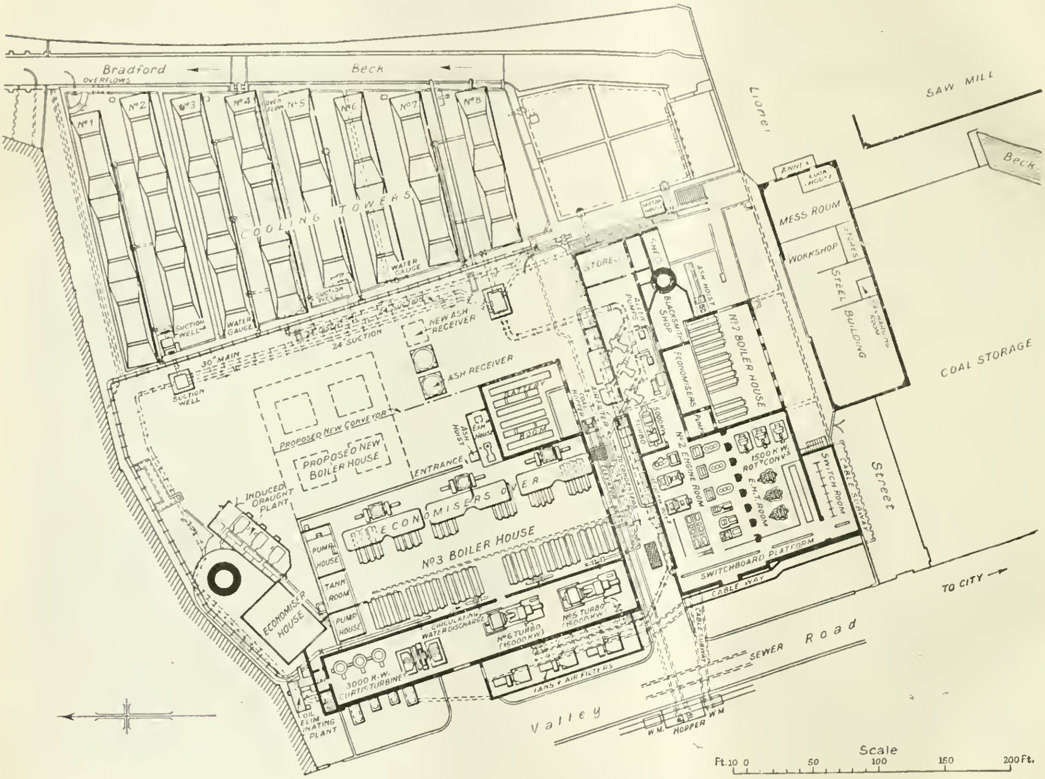

Fig. 1. General Lay Out of the Valley road Station, Bradford.

Ash Disposal and Feed Pumps.

The ashes are extracted by means of a Babcock & Wilcox suction ash plant of the ordinary type. Three Mather & Platt multi-stage centrifugal feed pumps, each with a capacity of 25,000 gallons per hour, are in use. Two of these are motor driven and one is steam driven by a single-stage impulse turbine, which exhausts into the feed tank. This turbine was supplied by Messrs. Peter Brotherhood, and develops 110 b.h.p. at a speed of from 1,400 to 1,600 revs. per min. Speed variation is obtained by hand regulation of the governor, the steam pressure being 150 lb. per square inch, with 50° F. of superheat at the turbine stop valve. Each feed pump is fitted with a combined integrating and recording Venturi meter.

The ten 18,000 lb. and two 25,000 lb. boilers, referred to above, are equipped with three induced draught fans, supplied by Messrs. Musgrave & Company (*see* Fig. 2). Each fan is driven by a 216 b.h.p. Phœnix direct-coupled, adjustable-speed continuous-current motor, and any two of the fans working in parallel are capable of handling the products of combustion from the 12 boilers when operating at full load. The speed adjustment is effected by means of a Westinghouse remote controlled device from the boiler house. The starting of these sets is effected by Westinghouse multiple lever starters, and the fan bearings are water-cooled and fitted with forced lubrication, which has worked very satisfactorily. In the case of the 32,000 lb. boilers, these are arranged in pairs, and the products of combustion from a pair of boilers are handled by two induced draught fans discharging to a mild steel stack. These fans are direct-coupled to 50 b.h.p. adjustable-speed continuous-current pipe-ventilated motors, made by Electromotors.

Generating Plant.

Turning to the generating plant No. 2, Valley Road station contains 7 Willans sets of the well-known type, having an aggregate capacity of 2,140 kw., and three motor-generators, which form a link between the direct and alternating-current sides of the supply, together with a 5,000 kw. Metropolitan-Vickers turbo-alternator which was put to work on October 29, 1915 (*see* Fig. 3). This turbine is of the Curtis impulse type, and develops full load when supplied with steam at 180 lb. per square inch gauge with a superheat of 100° F. at the turbine stop valve, and exhausting into a vacuum of 28 in. with the barometer at 30 in.

The condenser is of the Metropolitan-Vickers Leblanc surface type, having 12,500 sq. ft. cooling surface. It is capable of maintaining a vacuum of 27½ in. of mercury with a barometer of 30 in. when dealing with 95,000 lb. of exhaust steam per hour, if supplied with 540,000 gallons of cooling water per hour at an inlet temperature not exceeding 80 F. Duplicate air and condensate extraction pumps are provided, one being of the Leblanc twin rotary type together with a condensate extraction pump direct-coupled to a 55 B.H.P. back-pressure Curtis steam turbine running at 2,500 revs. per min, the other air pump is of the Leblanc compound steam ejector type with a motor-driven condensate extraction pump. The turbo-alternator generates three-phase current at 6,000 6,600 volts, with a frequency of 50 when running at 1,500 revs. per min. at 0·8 power factor. This machine is capable of taking an overload of 25 per cent. for two hours immediately after a full load run of 24 hours. A single-phase reactance coil is connected in each phase of the alternator. The exciter is directly connected.

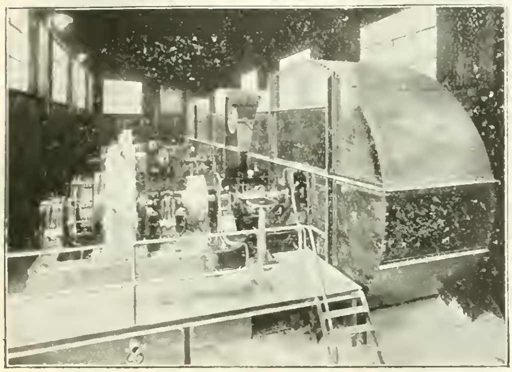
FIG. 2.—VIEW OF INDUCED DRAUGHT PLANT AT VALLEY-ROAD.

In addition, also, there are three 1,500 kw. Westinghouse self-synchronising booster rotaries, which are used for either lighting or traction work. The alternating-current boosters are mounted on the same shaft. There are also two 1 500 kw. Westinghouse rotaries, each having a mid-wire booster, which have been temporarily installed here before going to Bolton-road sub-station.

No. 3 Generating Station contains two 1,000 kw. low-speed reciprocating sets, which generate continuous current at 460 to 570 volts; two vertical turbo-alternators with an output of 3,000 kw.; and one vertical turbo-alternator, with an output of 4,500 kw. Some interesting comparative figures of the space occupied by these sets and the 1,000 kw. sets were given in the article to which we have already referred. The installation of these sets was experimental, but it was amply justified during last winter, when they carried regularly a load of 4,700 kw. to 4,900 kw. A view of these sets is given in Fig. 4. The latest addition to this station is a 15,000 kw. Parsons turbo-alternator, which is now just in running order. In addition, another 15,000 kw. set is on order.

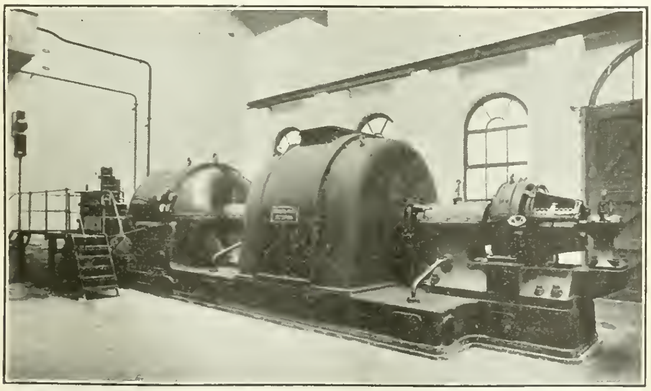
FIG. 3.—5,000 KW. 1,500 R.P.M. METROPOLITAN-VICKERS TURBO-ALTERNATOR.

This 15,000 kw. set was supplied by Messrs. Parsons, and is of the pure reaction single cylinder and single flow type. The turbine (*see* Fig 5) is designed for the following conditions: Steam pressure at turbine stop valve, 205 lb. per square inch absolute; superheat at turbine stop valve, 200 F.; absolute pressure at turbine exhaust branch, 2 in. Hg.; speed, 1,500 revs. per min.; normal rated output, 12,000 kw.; maximum continuous rated output, 15,000 kw; guaranteed steam consumption at the normal rated output, 11·9 lb. per kilowatt hour.

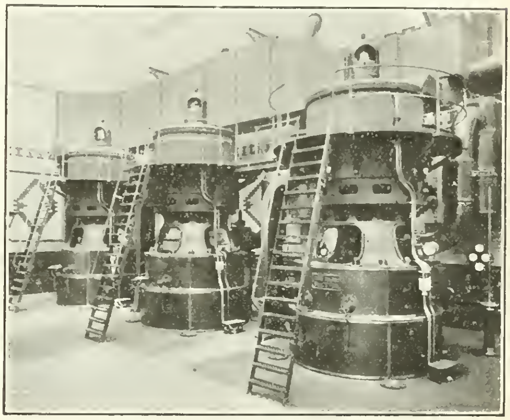
FIG. 4.—CURTIS TURBO-ALTERNATOR INSTALLATION.

The valve chest and high-pressure end of the turbine cylinder are of cast steel. There are 26 expansions. The blading for the first nine expansions is of Parsons end-tightening pattern. The mean diameter of the blading varies from 25¾ in. at the high-pressure end to 65 in. at the low-pressure end, the length of blades in the last expansion being 13 in. The thrust bearing is of the Michell type and the quantity of oil in circulation in the lubricating system is 1,000 gallons. The governor gear is of the steam relay design. The turbine is direct-coupled to the three-phase alternator by means of a flexible claw coupling.

The alternator is capable of continuously maintaining an output of 18,750 k.v.a. with a power factor of 80 per cent., and 6,600 volts between phases at 50 periods. The stator casting is in one piece. The rotor is constructed from a solid forging, and the rotor end coil retaining rings are of steel. Air for ventilating the alternator is supplied by external motor-driven fans, and the quantity of air required by the alternator is 70,000 cubic ft. per minute. Reactances are inserted in the generator leads; these are of the porcelain pattern, made by Messrs. Ferguson, Pailin, Ltd., and have a reactance of 5 per cent.

CONDENSING PLANT.

The condensing plant employed with this alternator is of the Hick-Breguet type supplied by Messrs. Hick, Hargreaves & Company. It is designed to condense 180,000 lb. of steam per hour, and to maintain a vacuum of 28 in. when supplied with cooling water at 80°F. It has a cooling surface of 29,500 sq. ft. In the lower part of the condenser an aspiration chamber is provided to ensure the air being withdrawn at a maximum density. The condenser is supported on springs, the idea being to relieve the turbine of any stress, and suitable expansion pieces are provided to allow of free movement under all conditions of running.

The duplicate electrically-driven extraction pumps are of the centrifugal single-stage type, and are arranged to deliver against an external head of about 50 ft., suitable valves being provided so that each pump can operate independently of the other. Three electrically-driven centrifugal circulating pumps were supplied by Messrs. Mather & Platt, each being capable of delivering 1,530,000 gallons per hour against a head of 50 ft. These pumps are installed in a separate building.

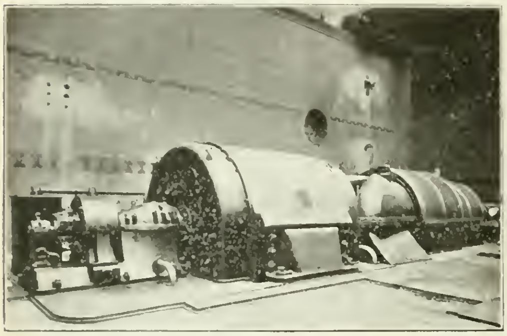
FIG. 5. 15,000 KW. PARSONS TURBO-ALTERNATOR.

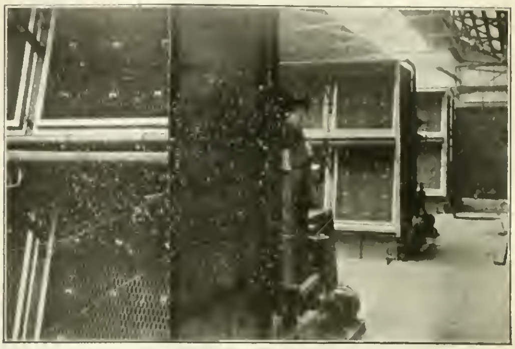
FIG. 6.—HEENAN AND FROUDE AIR FILTERS FOR 15,000 KW. TURBO-ALTERNATOR.

The method of extracting the air in this condensing plant is of interest. A steam jet apparatus, known as an "Ejectair," is used. It consists of two steam jets in series with an auxiliary condenser between them. The water used by the latter for condensing the steam from the first jet, and cooling the air discharged therefrom, is obtained from the extraction pump discharge, thus ensuring a supply of de-aerated water for this purpose. This water is returned to the extraction pump by means of a U pipe, which automatically maintains the difference of pressure between the main and auxiliary condensers. This arrangement also ensures that the heat of evaporation in the steam issuing from the first jet is returned to the feed water, and so a high thermal efficiency is obtained. The discharge from the second jet is led into a surface feed heater, which enables the heat on evaporation in the steam issuing from this jet to be utilised in a similar manner. To enable the plant to be started up before the main unit is put into commission an independent water supply is provided for the condenser. Illustrations of this arrangement are given in Figs. 7 and 8.

AIR FILTER PLANT.

In connection with this set two large Heenan & Froude's air filters have been installed, which are shown in Fig. 6. As will be seen, the body of this filter is rectangular in shape, and is built up of stiffened steel plates mounted on a substantial base, which forms a tank. The filtering effect is obtained by drawing the air through two sets of screens fitted one behind the other in the front part of the filter. These screens are made of metallic wool, which is closely packed between frames of expanded metal. The air thus drawn in is thoroughly cleansed by water which is continually passing over the screens, the water supply being maintained by means of a small centrifugal pump fitted to the side of the filter. The water is delivered to the top of the first screen, and, after percolating through the screen, falls into the tank at the bottom of the filter, where it passes through a strainer and returns to the pump for recirculation. The air after passing through the screen meets a series of fixed eliminators, which catch and throw down any small particles of loose moisture that may have passed the second screen. Besides cleansing, this process has a cooling effect, reducing the temperature of the air to within a few degrees of the wet bulb temperature. The volume of air required for cooling this particular alternator is 70,000 cubic ft. per minute, and this amount is satisfactorily dealt with by the particular filter that has been installed. It is claimed that by this arrangement all danger of moisture finding its way into the generator winding is avoided.

SWITCHGEAR.

The whole of the plant in both stations is controlled from switchboards in No. 2 station, where also is to be found the switchgear for operating the feeders. The greater portion of the high-tension three phase switchgear has been assembled in the electricity department's own workshops, the necessary switches, transformers, &c., being, of course, obtained from the usual well-known makers. Three single-core paper-insulated lead-covered cables, each 0·5 sq. in., are run from each of the vertical turbo-alternators to the switchboards, and to protect these connections, which are of considerable length, the Merz-Price protective system has been installed. For the new set the main cables connecting the alternator to the oil switch are single-core lead-covered and paper-insulated 1 sq. in., sectional area, two being used per phase.

A signalling system is provided for communicating between the switchboard and the engine room, but the control of the plant is, nevertheless, largely in the hands of the switchboard attendant, who, by means of a motor-operated gear, can adjust the speed of each set during synchronisation. The continuous-current generators are also controlled by means of remote control gear, which is mounted on a special desk. A view of the extra-high-tension board is given in Fig. 9.

FEEDER CONTROL.

The feeders are controlled from a switchboard on the level of the engine-room floor. This comprises 12 panels for controlling an equal number of continuous-current traction feeders and a traction total

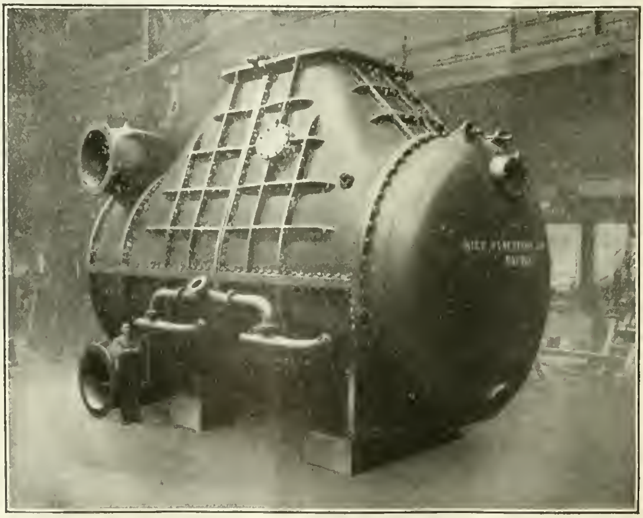
FIG. 7.—VIEW OF HICK BREGUET CONDENSER.

load panel. On a gallery above the engine room are panels for controlling 24 continuous-current power and lighting feeders.

Great care has been taken in the lay-out of the switchgear. All the main connections are made of copper bars, whilst for the smaller connections No. 1/14 S.W.G. rubber-insulated asbestos-covered conductors are employed. The feeders are all of the six-core type, three cores being for the main conductors and the other three pilot wires from the corresponding feeding point.

The switchgear for controlling the new turbo-alternator set has been supplied by the Metropolitan-Vickers Electrical Company, and is of their ordinary standard pattern. Voltage regulators of the Taylor-Scotson type are provided in connection with the vertical Curtis turbines and the horizontal Metropolitan-Vickers sets. A Sandycroft battery having a capacity of 350 amperes on the one-hour discharge rate is used for operating the remote controlled gear, trip circuits, and excitation, &c. In connection with the three-wire continuous-current system there is installed a storage battery made by the Chloride Electrical Storage Company, having a capacity of 5,000 amperes for one hour. The boosters and battery switchgear for this installation were supplied by the Phœnix Dynamo Mfg. Company, and Bertram Thomas respectively. A neutral earthing resistance of the grid type with resistance of 8 ohms is also installed.

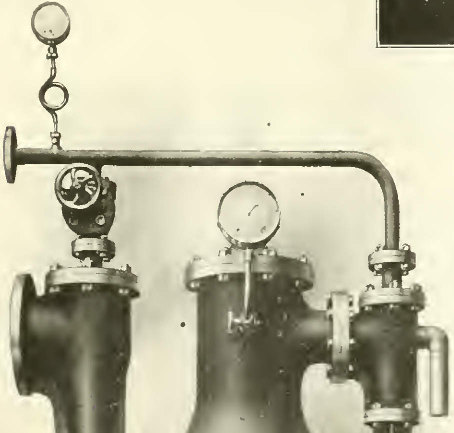

Fig. 8.—View of the "Ejectair" Arrangement.

Sub-stations.

Conditions at Bradford make the installation of a sub-station of the standard type very difficult though standardisation has been carried as far as usefully possible, so that by describing one traction and one lighting and power sub-station the general lines of all similar stations are indicated. The traction sub-station which we inspected contained two 250 kw. rotary converters. These machines are started up by means of a special starting motor, and are then synchronised. The sub-station also contains a 60-volt battery for operating the switchgear relays.

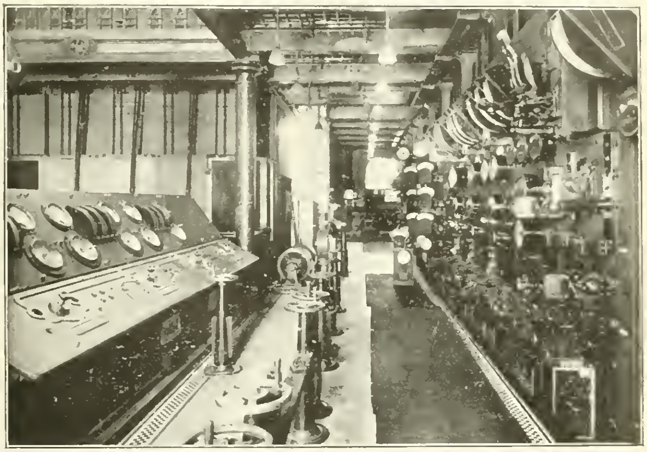

Fig. 9. E.H.T. Switchboard and Control Desk.

The rotary fields are shunt wound, and all the traction sub-stations are operated in parallel. At each sub-station there is an interconnecting feeder to the Valley-road generating station, which is fed from both ends, a special signalling arrangement being provided to show the condition of both of its ends. A watt meter and ammeter are provided on each feeder panel for measuring purposes, and in addition there is a master sub-station meter, upon whose readings the charges to be made to the tramways department are based. The rotaries are supplied through two sets of single-phase shell-type transformer, each with a capacity of 100 k.v.a.

In general, the site of a traction sub-station is also combined with that of an ordinary static sub-station for power and lighting purposes. In this particular station, therefore, two three-phase core-type transformers, with a capacity of 150 k.v.a., and connected delta star, were installed for supplying the network. A small motor-generator is provided for charging the 60-volt battery. Each station has private telephone communication with the Valley-road generating station.

Some of the largest sub-stations are built on the consumers' premises, and supply, not only the large consumer, but the network as well. Of these, that installed at the works of Messrs. Mitchell Brothers is typical. Here are erected one 800 k.v.a. transformer and one 600 k.v.a. transformer. These both supply Messrs. Mitchell Brothers' works. In addition, there is one 300 k.v.a. transformer for supplying the needs of the district.

Special mention may also be made of the Thornbury sub-station, which, in addition to gear similar to that which we have just described, is interesting from the fact that here connection is made to the mains of the Yorkshire Electric Power Company through an 0·15 sq. in. feeder. Measuring instruments are installed, so that current supplied from the Bradford Corporation and the Yorkshire Electric Power Company, and vice versa, can be metered. It is interesting to note that in this case one of the consumers in the Yorkshire Electric Power Company's area is supplied by the company through the Bradford Corporation sub-station.

An Electric Furnace Load.

An interesting plant supplied from the Bradford Corporation mains is that on the premises of Messrs. Thwaites Bros., Ltd. It consists of three single-phase high-voltage electric furnaces which are maintained in constant operation day and night five days a week. Each furnace has a full load demand of 400 kw., which power load cannot be exceeded owing to the inclusion of a sufficiently large reactance in the furnace circuit.

The nominal full-load current of each furnace is about 3,000 amperes, and the normal voltage is about 135 volts across the furnace terminals. Each furnace draws supply from a separate 600 k.v.a. oil cooled step-down single phase transformer, the three transformers being connected in mesh across the Corporation high-tension bus bars through the necessary switchgear. The transformers are specially constructed with high inherent reactance, in addition to which separate external reactance coils are employed.

In the case of the first two furnaces installed, these separate reactances together with the necessary furnace switchgear, are connected on the secondary or low tension side. In the case of the third furnace both switchgear and reactance coil are connected on the high tension side. The existence of these separate reactances permits control of the furnace input by varying the amount of external reactance concerned.

In the case of the low-tension reactances such variation is accomplished by short-circuiting or open circuiting certain sections of the reactance coils. In the case of the high-tension reactance, control is effected by varying the reactance tappings by means of a high-tension selector switch interlocked with the main high-tension furnace switch.

The furnace switches, both high-tension or low-tension, are remote controlled and are of the standard Ferranti type. Auxiliary hand control is provided in case of breakdown of the remote control or to permit in emergency of operation from within the sub-station.

The sub-station plant includes a motor generator set consisting of a three-phase synchronous self-starting motor direct-coupled to a 600 kw., three-wire, 470-volt, direct-current generator. The three-phase motor is designed for use as a power factor improver, and is normally heavily over-excited to take a line current of approximately 110 amperes per phase. The load on the direct current side does not in general exceed 260 kw. The effect of this machine is to improve the power-factor of the furnace load from 0·55 to 0·75.

This set is controlled by high-tension interlocked Ferranti type cubicle switchgear, and a rotor starter consisting of a series of oil switch cubicles controlling the steps on a bank of cast iron resistance grids. The furnace consumption is 100,000 units per week.

New Offices and Showroom.

The accommodation at the Town Hall having been found to be inadequate for the enlarged activities of the department, the Electricity Committee recently purchased a nine-storeyed building in Sunbridge-road for the purpose of accommodating the administrative and office staffs, the consumers' and testing departments and providing a large showroom, with a frontage of 60 ft. on to the main street, where sales and demonstrations of electrical consuming devices can be carried out on a large scale. Arrangements are now being made for altering the above-mentioned building so as to make it suitable for occupation, and at the present time the sales department is occupying a small portion of it.

Conclusion.

We have to thank Mr. Thomas Roles, city electrical engineer and manager, for permission to describe the various interesting points of the Bradford Corporation undertaking, and for supplying us with the photographs and drawings which illustrate this article. We also have to thank several of Mr. Roles' assistants for spending a good deal of time with our representative explaining the details at Valley road station and the sub-stations.

The Phenomena of Switching in Oil and the Possibilities of Standardising the Apparatus.*

By P. CHARPENTIER.

In May, 1914, the author contributed an article to "La Revue Electrique," giving several considerations serving as a basis for the opening of a discussion of the various problems raised by the use of oil switches. A more recent Paper, of which the present article forms an abstract, is intended to enlarge the field of this discussion, in view of the fact that l'Union des Syndicats de l'Electricite is about to draw up the standard rules for apparatus of this nature.

Switching in Oil.—The Creation and Rupture of Arcs.

In general, the final break of the circuit in an oil switch takes place between the auxiliary contacts, so that we will assume that the fall of potential between the main contacts is zero, and will examine what takes place when the auxiliary contacts separate, the circuit being the seat of sinusoidal alternating currents and the break taking place in oil.

As soon as the metallic contact is broken the gap is traversed by a spark, the intensity of which depends upon the self induction and on the value of the main current in the circuit at that instant. If the current were passing through zero there would be no spark due to self induction; further, there would be no spark if the capacity of the circuit were such as to absorb exactly all the potential energy released by the interruption. Evidently one cannot hope to realise this latter condition. With regard to the former, it may be mentioned that the sinusoidal rate of variation of the current is maximum when the current is nothing, and zero when the current is maximum. Hence there is a greater chance of the contacts being separated in the neighbourhood of the maximum than of the zero current.

But, even if the current is exactly zero at the moment of the separation of the contacts, it does not follow that the current will definitely be broken, for at this moment the difference of potential that is established between the contacts is equal to the electromotive force acting in the circuit. As the length of the gap between the contacts starts from zero, a relatively feeble value of the E.M.F. will suffice to rupture it. If this E.M.F. is zero at exactly the same instant as the current (which will never be realised in practice), there may nevertheless be a discharge when the E.M.F. increases more rapidly than the voltage necessary to rupture the thickness of the gap.

A Spark Inevitable.

The nature of this discharge depends on the constants of the circuit and the instantaneous value of the current, but is of no further interest at present. The important fact to realise is that, with apparatus of the usual type, the existence of a spark at the first moments following the separation of the contacts is inevitable.

Let us consider the conditions necessary for this discharge to be followed by the current circulating in the circuit, that is to say, the conditions necessary to the establishment of an arc. The spark creates a more or less conducting path between the contacts, but the main current can only follow this path under certain conditions. When an arc has been established between two electrodes, to maintain this arc, it is necessary:—

1. To maintain a certain minimum potential difference between the electrodes;
2. To dispose of sufficient energy or current to maintain the crater of the negative electrode or cathode at a definite temperature;
3. That the pressure in the atmosphere surrounding the arc shall not exceed a certain maximum, depending upon the value of the potential difference and the current.

The potential difference between the electrodes is composed of the voltage drops at the anode and cathode between the electrodes and the arc, and the fall of potential in the arc itself. The former depend upon the nature of the metal forming the electrodes and upon the medium separating them, and the latter depends upon the nature and pressure of the medium and the length of the arc. The minimum temperature that must be maintained at the negative crater is the fusion temperature of the metal. These conditions correspond to Ayrton's formula.

So far as the influence of the pressure of the atmosphere surrounding the arc is concerned, it is only known that for a given value of the potential difference between the electrodes, and of the current, the arc cannot exist when a certain pressure is passed.

But at the instant of separating the contacts the potential difference and current necessary to kindle the arc are reduced owing to the existence of the spark due to the rupture of the circuit.

As this spark has an appreciable duration, even if the current is nil at the moment of separating the contacts it rapidly reaches a value sufficient to free the gap and follow the spark, especially in the case of powerful short-circuits. As for the voltage it is never zero at the same instant as the current, and in the case of an interruption on short-circuit, it will always be in excess of the necessary minimum value. In consequence, the establishment of an arc in the first half period which follows the opening of the contacts, is practically inevitable, and the extinction of this arc will depend upon phenomena which will be discussed later.

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* Abstract of an article in "La Revue Electrique."

Rupture and Re-establishment of Arcs.

In a simple alternating current circuit with a single switch consisting of two copper electrodes which can be separated vertically under a given depth of oil, the sole factor that can have an influence on the duration of the arc in the first half period following its creation is the speed at which the electrodes are separated. If an infinitely great speed could be imparted to the contacts it is obvious that the arc would extend in an infinitely short time, during which it would take such a length that the voltage available in the circuit would be entirely absorbed by the falls of potential at the electrodes and in the arc. If, also, the resistance introduced by the arc in the circuit, in this interval of time were sufficient to reduce the current below the minimum value necessary to maintain the arc, the arc would be broken. It thus appears that, assuming the extinction of the arc to be possible during the first half-period, the duration of the arc is not a definite characteristic of the rupture. It is, on the contrary, the maximum theoretical length of the arc that is defined by a given circuit and load conditions. It is further necessary, when only the first half-period following the interruption is considered, to take account of the instant at which the arc is produced, and of the variations which take place in the current and the voltage as the arc lengthens. The maximum length for the arc thus varies at each instant. It will be zero before the current is quite annulled, and the arc will be broken a little before the current passes through zero value whatever may be the maximum value of the alternating current.

With finite speeds the critical length of the arc in the first half-period will only be reached very near to the zero current, and the greater the maximum value of the current the smaller will be this time difference. The rupture of the arc during the first alternation will therefore take place in the immediate neighbourhood of the passage of the current through zero value, even on the interruption of very heavy short circuits. But, however heavy they be there is a definite rupture, and, from this instant the critical length continues to diminish until it reaches zero.

Conditions on Short Circuit.

In the case of a short circuit, the voltage and current being considerably displaced, there will be a discharge between the electrodes through the ionised metallic vapour which the oil has not time to reduce. The current will follow this discharge if it has attained a value determined by the condition that the crater of the electrode which is about to become the cathode must still have the critical temperature necessary for the passage of the arc. This condition will depend upon the quantity of heat given to the anode by the preceding arc, on the quantity dissipated by conduction, and, in consequence, on the intensity of the current, its duration during the first half-period, and on the duration of the suppression of the arc. The temperature of the anode is always much higher than that of the cathode; it is thus at least equal to the fusing temperature of the metal. The electrode which will become the cathode after the current passes through zero, will produce particles of molten metal, the temperature of which will remain constant, with the liberation of heat, during solidification.

Possibility of Re-establishment of Arc.

These combined conditions explain the possibility of the re-establishment of the arc after its rupture at the end of the first half-period. The voltage absorbed by the fall of potential at the electrodes and in the arc will be available by reason of the lag; the fall of potential in the arc being more over diminished by the discharge set up by the voltage. As for the current it will encounter at the beginning of the second half-period a cathode at the temperature of fusion of the metal; the slightest heating effect, and, in consequence, a small current will suffice to create the negative crater and to give it the surface necessary for the increasing values of the current.

So with high voltages and large currents, a final rupture of the current during its first passage through zero need not take place, contrary to the condition obtaining for low tension air switches, where the fall of potential between the electrodes is an important fraction of the electromotive force available, and where the surface of the craters is too small to absorb any marked quantity of heat.

Influence of Calorific Effects upon Rupture.

So far the heating effects of the arc have not been dealt with. There is only a sudden release of energy taking place in about one-hundredth of a second; an examination of pressure records shows clearly that the heating effect round the arc only begins to be noticeable after an appreciable interval of time. Nevertheless, the quantities of electrical energy transformed into heat follow the changes in the current. There is thus a maximum heating effect corresponding to the maximum current, with a time lag of the order indicated. In the vicinity of zero current, on the contrary, the heating effect is very small, and even nil during the time for which the arc is interrupted. At this stage the negative crater dissipates more heat than it receives, and tends to cool. Then, if, as is usually the case for fairly high voltages and for the phase relations obtaining during short circuits, the voltage available in the circuit is sufficient to jump the gap between the electrodes, the sequence of the phenomena following the first passage of the current through zero value, and especially during the second and third half-periods when the gap between the electrodes is still of little importance will depend upon the total quantity of heat developed at the negative crater from the beginning up to the instant under consideration, and on the quantity of heat dissipated in the same time. If the difference at a given moment is such as to reduce the temperature of the negative crater below the fusing point, there is a final rupture of the arc. Similarly, if the heat furnished during the half-period preceding an interruption of the arc is sufficient to maintain the negative crater at the fusing temperature of the metal, the arc will re-establish itself, and if the gap between the electrodes remained constant, there would be a permanent arc.

There is, however, an essential difference between the arc occurring in the first half-period and that re-established in the following half-periods. The first takes place in an atmosphere purely metallic, or only composed of ionised vapour of the metal charged with incandescent metallic particles. The following arcs on the contrary are produced in a mixture of metal and oil vapours, of decomposed and dissociated gases. The calorific effects of the arc itself at its periphery, develop with time lag in a way analagous to those just indicated in the case of the craters. This phenomenon has been but little studied, but it appears to the author to determine the length of the arc in oil.

The Form of the Gaseous Sheath.

In the second half-period it may be admitted that the crater in oil, and a part of the neighbouring contact surface, are situated in a gaseous atmosphere. The cooling effect of the oil is almost inappreciable, and has not time to modify in any marked manner the transmission of heat around the crater. In short, the radical difference between the behaviour of the arc in air and in oil is not due to the mere immersion of the contacts in oil. In the arcs themselves, on the contrary, the conditions are totally different. In the first half-period which follows the separation of the contacts the arc makes for itself a passage in the oil, with a development of heat which manifests itself with a certain time lag. The arc will be extinguished by the time that this effect shows itself in the production of a gaseous sheath composed of oil vapour and of the products of decomposition.

Arc Extinction.

The moving contact continuing its course during the extinction of the arc when the current first passes through zero, the gaseous envelope expands between the fixed contact and the point reached by the moving contact at the first extinction. Between this point and that where the arc picks up again there will be evaporation of oil around the moving contact, but the volume of gas produced is very much less than around the arc. Moreover, the moving contact sinks into fresh layers of cool oil. Until the heating effect of the second half-period makes itself felt, the sheath due to the first half-period continues to expand and to give out heat to the surrounding oil. But the lower part of the sheath continues to lengthen, and the space produced by the motion of the contact becomes filled with vapour. The heat developed during the second period results in a certain quantity of heat being given to the dilated sheath formed in the first period, and a further amount being used to form a new sheath between the positions corresponding to the two zero currents which limit the period. The effective value of the current varying but little, it follows that the quantity of heat given to each of these successive bubbles diminishes with the number of periods for which the arc persists.

Some Results.

As a result: The region of the first sheath receives most heat, and the gaseous bubble thus tends to take the form of a string of beads of graded sizes. This form obviously is very unstable, and the gaseous mass tends to assume a spherical form. There is a tendency for the mass to move upwards, and for the lower, drawn-out part to be strangled.

Further, at the end of several half-periods the quantity of heat given to the oil in the path of the lower contact corresponding to the latest half-period becomes smaller and smaller. This heating effect takes still longer to manifest itself, and the gaseous track left by the lower contact becomes more and more narrow. The end of this contact is, moreover, cooled energetically by its motion through the oil. During the extinction of the latest arc, the contact continues to fall and to create behind it a vacuum which can only be filled by gas from the previous sheath, or by oil. After a certain number of extinctions of the arc the bubble becomes strangled, the contact sinks into the oil and the arc is finally broken.

It should further be mentioned that the gaseous sheaths consist of a very large proportion of hydrogen, a relatively good conducting gas, and, in consequence, favouring cooling; and, in addition, it is more difficult to maintain an arc in hydrogen than in air.

Influence of the Speed of Operation.

With a finite speed the arc will persist for several half-periods but it is conceivable that when the speed is sufficient to separate the contacts by a distance corresponding to the critical length of the arc at each instant, nothing is to be gained by further increasing this speed. During the first half-period the critical length is probably considerable, and comparable with that for an arc in air. The greater the lengthening of the arc in this first half-period the greater is the production and the greater the ionisation of the metallic vapour along this path. On the other hand, following the first passage through zero it is desirable to speed the moving contact as quickly as possible, and to promote the cooling and immersion of this contact in the oil. It is certain from what has been seen of the form of the gaseous sheaths that a high speed during the stage when the arc is extinguished will be very favourable to its final rupture. The sheaths would then be much more attenuated, and would be strangled much more readily.

The Influence of Multiple Breaks.

Similar observations apply to multiple breaks. The speed of operation must here be considered relatively to each of the arcs; sub-division naturally diminishes the critical length of the component arcs, so that for a given speed of manipulation it is advantageous to employ multiple breaks if the speed corresponds to gaps greater than the critical lengths of the various arcs. Otherwise, the effect of using multiple breaks depends solely upon the difficulty has the available current in maintaining several cathode craters in series instead of one.

Calorific Effects of the Arc.

The safety of the operation of an oil switch depends on the manner in which the various heating effects of the arc develop. Qualitatively these effects may result in the liberation of fumes, the projection of oil, the breaking of the tank rivets, explosions, burning of the contacts, &c. Lengthy experiments are necessary to determine quantitatively the calorific power corresponding to the interruption of the current under known conditions of current and operation, and to determine the conditions under which this calorific power can develop in the switch in perfect safety. But it is probable that improvements in design will make these researches unnecessary, and that the practical realisation of breaking in perfect safety the most formidable short-circuits will take place before the experiments could be completed.

The Power Interrupted.

The difference of potential which tends to be established at the rupture of the arc will depend upon the short circuit current at that instant. As this current determines the heating effects of the arc the product of the aforesaid difference of potential and the short circuit current is certainly a factor determining the energy of the rupture of the arc, and this product may be called the power interrupted or the capacity of the interruption.

Interruption of Large Powers on Short Circuit.

In 1916 the A.E.G. published the results of short circuit experiments on a group consisting of a three-phase 15,000 k.v.a., 7,500 volt generator, driven by a 1,100 kw. asynchronous motor, and a transformer of the same power as the generator transforming up to 85,000 volts. The rotor of the generator weighed 50 metric tons; the leakage reactance of the generator was 6 per cent., and as a result the machine could give very large short-circuit currents with a relatively feeble damping. Also it was not necessary to switch off the motor at the instant of the short circuits as the speed of the generator only fell by about 5 per cent. Oscillograph records were taken of the current and voltage between the contacts, and the speed of operation of the switch was measured by means of a recording drum. The interval of time between the closing of the short circuit and the rupture of the arc was so small that armature reaction had not time to act, and the voltage between the contacts when the rupture occurred differed but little from the open circuit E.M.F. of the generator. So far as voltage current and phase displacement are concerned the switch thus operated under the most unfavourable conditions. By strengthening the excitation very much during the short duration of the test it was possible to obtain from 10 to 20 times the normal power from the generator. These experiments show that the duration of the arc increases rapidly with the phase displacement up to 20 deg. very slowly from 30 to 60 deg., and hardly at all from 60 to 90 deg. The experimenters concluded that with multiple breaks the influence of the number of breaks on the duration of the arc was due to the multiplicity of the arcs rather than to the augmentation of the total speed of separation of the contacts. But the present author interprets the results to show that the influence of the speed is far from being negligible. The use of extinction chambers disposed around the contacts results in an improvement of the same order as the use of quick break contacts in which the natural speed of the contact is added to that of the main traverse. The combination of the quick break action and extinction chambers has enabled 450,000 k.v.a., three-phase to be broken in one hundredth of a second at 7,550 volts, with simply a double break. In interrupting 105,000 k.v.a., three-phase, at 80,000 volts, with extinction chambers and ordinary contacts without a quick break action, the arc persisted for eight half-periods.

Standardisation of Apparatus.

It follows clearly from the previous discussion that oil-switches can break the most .powerful short-circuits with safety if the apparatus has been studied and dimensioned suitably for the service on which it is to be employed.

The factors governing these dimensions are:—

1. The normal working voltage of the system;
2. The normal full load current;
3. The potential difference E_c which tends to be established between the contacts when the arc is broken, and which is equal to the open circuit E.M.F. of the alternator dimished by the true armature reaction.
4. The total possible intensity I_c of the short circuit current at the beginning of the interruption;
5. The phase displacement,
6. The frequency and the wave form of the current.

The power actually interrupted, that is to say, that actually delivered by a generator to a central station oil switch at the beginning of the interruption may differ by a fair amount from the product $E_c I_c$. But these two terms, together with the frequency and the phase displacement determine the energy developed during interruption the former E_c, influencing especially the duration of the arc, and the latter I_c its power.

The Need for Systematic Experiments.

Every manufacturer ought to know and to be able to indicate the extreme limiting conditions for which all the apparatus he produces may be employed. It is no solution to furnish an apparatus which is three or four times more powerful than is necessary.

In brief, the experiments to be undertaken are simply to determine: (1) Under what depth and pressure of oil, (2) At what distance from the sides of the tanks, (3) At what speed, (4) and to what total distance must the separation of the auxiliary contacts be carried in an oil switch of modern construction, in order that a short circuit may be broken in perfect safety. The criterion of this safety may be taken to lie in the absence of the projection of oil during the interruption, and in the possibility of reclosing the switch on a short circuit at least once without danger after a first break. To be decisive the experiment should determine the value of the intensity of the short circuit necessary to put the switch out of action (by fire or explosions). For a given short circuit current and voltage the experiments should determine the pressure and the minimum thickness of oil around the contacts, the minimum speed, and the total minimum distance between the contacts necessary to obtain a normal break, that is, without projection of oil.

Test Centre Necessary.

To carry out these tests it is not practicable to make use of existing installations, and it is necessary to establish a centre for carrying out tests at high voltages and involving large powers. A 15,000 to 20,000 kw. alternator, having a rotor of great mass, and driven at a high speed by a 1,200 to 1,500 h.p. motor, and a transformer of 100 to 120 kilovolts, of the same power as the generator are the essential machines necessary for these tests. Owing to the inertia of the rotor, 200,000 k.v.a., sufficient to test the most powerful apparatus, can be taken from this group for a few hundredths of a second. This power would be produced by short circuiting the generator or the transformer after running up the set. By means of an oscillograph, records of the voltage, the current, the duration of the interruption, &c., could be obtained. Failing these experiments the only other method of bringing about a standardisation of oil switches that appears to the author is to glean from here and there various odds and ends of the German, Swiss and American regulations, and from them to make a compromise for the use of the French electrical industry.

Shipley Electricity Works.

The electricity works of the Shipley U.D.C. a thriving township some three miles north of Bradford—are not large, but nevertheless contain features of much interest. The site of the present works was originally chosen in 1896 for sewage outfall and destructor works alone, but at a later date it was considered it would be an advantage to have the electricity works also on the same site, in order that the steam raised by the destruction of refuse might be used in the production of electricity.

The Council obtained powers to provide electricity in 1899, and in July, 1900, a supply was given, there being three consumers, whose total load amounted to 3 kw. The plant consisted of a 30 kw. steam set and a 750 ampere-hour battery. Steam was supplied by one 8 ft. by 30 ft. Lancashire boiler attached to a 4-cell Meldrum destructor—both of which are still in active service.

The generator was replaced in 1901 by two 240 kw. direct-current Parsons turbo-generators which, at that period, were a debatable problem, and Shipley thus became the pioneers in Yorkshire for the turbine drive in supply stations. These turbines attracted a great deal of attention, and many deputations of engineers from various towns came to inspect them. The cable system then laid down consisted of four main feeders, terminating in disconnecting pillars at four central points of the district and interconnected with distributor cables, thus enabling each feeder to be an independent unit, or to feed into the general system as desired.

The use of electricity rapidly advanced and by 1905 four boilers and four turbo-generators with a total capacity of 1,000 kw. were installed. These generators are still available for service, though their use is now largely confined to peak load duty. They form, however, points of much engineering interest, especially in comparison with the modern turbo-alternators now supplying the general demand.

Further growth in the load made it necessary to extend, and in 1912 the Council decided to install additional plant on the most modern lines. Accordingly, two 20,000 lb. Babcock boilers and two 1,000 kw. Westinghouse turbines with Phœnix Company's alternators were installed, and these now carry the bulk of the load. The steam pressure is 160 lb. per square inch and superheated to about 550°F. The alternators run at 3,000 revs. per min., and supply a three-phase current at 6,600 volts. The cooling air is provided by an independent motor-driven fan which keeps a predetermined air pressure in the turbine casing, baffles being fixed between the casing and revolving shaft to prevent the escape of air before traversing the windings.

For the conversion of high-tension alternating-current to low tension continuous-current two rotary converters are provided—one 500 kw. and one 300 kw.—and the smaller one is arranged to work either direct or inverted. Both machines are arranged for feeding low-tension power, lighting or traction.

The main switchboard is noteworthy for the substantial character of the gear and its simplicity is explained by the fact that all distribution is done from a large sub-station in the centre of the town. The demand on the station is rapidly growing and application is being made for additional plant.

During the past winter the station, in addition to supplying the town's requirements, has been of much service to its larger neighbour, Bradford, who have suffered serious inconvenience in consequence of trouble to part of its generating plant.

Our thanks are due to Mr. W. Redman, the Council's engineer, for assistance in preparing this notice.

The annual report of the Weights and Measures, Electricity and Gas Inspection Services of the Department of Trade and Commerce of the Dominion of Canada states that during 1918-19 the number of electricity meters tested were 140,336, an increase of 12,943 over the previous year. The gas meters (73,324) tested showed a decrease of 1,842. Of the electric meters 54,674 were found to be correct; only 158 were found to be over 3 per cent. fast and 371 over 3 per cent. slow. Of the 3,401,659,947 units generated 1,143,277,969 units were exported, the remainder being used in Canada. The Report contains a list of the companies and municipal councils supplying electricity, &c., system of generation, service voltage, &c.

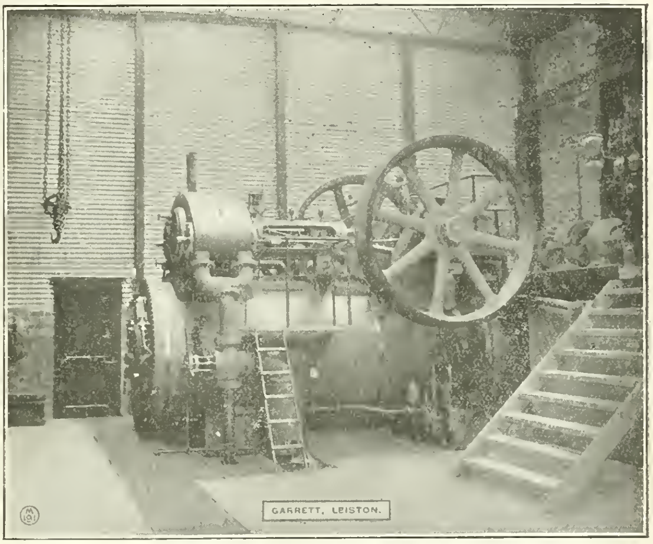
Electricity Supply at Ilkley.

The facilities available for enjoyment by members and visitors to the annual convention of the Incorporated Municipal Electrical Association at Ilkley are so many that doubtless most of those present will find more than enough to occupy their spare moments on the two golf courses and in making walking and driving excursions over the moors both near and far to find time to visit the electricity works. Nevertheless, a few enthusiasts will probably make their way to Little Lane, and those who do so will be amply repaid for their trouble. For the station, though small, is interesting, and has had a short but most successful existence.

The Generating Plant.

The generating plant consists of two 180 b.h.p. locomobile plants made by Messrs. R. Garrett & Sons, of Leiston, one of which we illustrate. This may be correctly described as a semi-stationary plant, as any one unit consists of a complete set of all the parts which go to form a complete steam plant—*i.e.*, boiler, superheater, engine, condenser, air pump and feed pump, the various parts being so disposed that a very compact and self-contained whole is obtained, making easy inspection and overhaulage impossible.

The boiler is of the cylindrical single flue multi-tubular type, and the furnace and tube system are so designed that they can be readily disconnected and withdrawn, so that the inside of the boiler can be thoroughly cleaned and inspected with the greatest of ease. One of the disadvantages of using a boiler of the tubular type is thus overcome. Heavy pressed steel facings are rivetted to the top of the boiler, and on these are mounted the cylinders and main bearings of the engine. The engine is of the side-by-side compound type, with piston valves, both cylinders being entirely surrounded by a steam jacket directly connected to the boiler, and forming an extension of the steam space of the boiler.



View of one of the Steam Plants.

Governing is effected by varying the cut off in the high-pressure cylinder by means of a crank shaft governor, which gives a very close regulation of speed. The superheater consists of solid drawn steel tubes arranged as zig-zag coils. This is connected at each end to cast-steel headers, and is placed on an extension of the smoke box. The condenser is of the surface type with an Edwards' air pump driven by an eccentric on the crank shaft. The boiler feed pump is connected to the air-pump cross-head. Each engine is provided with two flywheels, either of which is capable of transmitting the whole power by means of silent chains. Lubrication is so arranged that the minimum amount of attention is required, and the labour costs are thereby reduced. The space occupied is inconsiderable, the foundations required are inextensive, and the complete plant can be erected and put to work in a very short time, so that it will be seen there are several definite advantages in employing this class of equipment for a small generating works. There is a cooling pond with spray cooler and simple switchgear for portions of the machines and feeders is provided.

The supply is on the continuous-current three-wire system, with 460 volts across the outers. Besides Ilkley, the electrical wants of the small adjacent Councils of Middleton and Ben Rhydding are also being supplied.

Since the station was started in January, 1916, the progress of electricity supply in Ilkley has been very satisfactory. This is not surprising when we state that lighting is supplied at 6d. a unit, and heating and cooking at 1½d. a unit. Being mainly a residential and a pleasure resort, there is, of course, but a small demand for power, but at the same time great inroads have been made into the number of gas consumers, and practically all the large hotels have changed over to the more modern method of working, and the connected total now amounts to 600 kw. The only thing which prevents further developments in this direction is the difficulty at the present time of extending the station.

The Saltaire Mills.

Of all the great industrial enterprises built up round Bradford during the latter half of the nineteenth century, none are more impressive than that of Sir Titus Salt, Bart., & Sons, Ltd. As a visit to these works forms part of the programme of the Convention, a brief description of them and their electrical equipment will be of interest

This undertaking, standing on one bank of the River Aire, takes its place-name from the combination of the names of the river and the founder of the mills, and affords employment for about 3,000 people. The raw materials to be manufactured, which are imported direct from South Africa, Australasia, India, China and South America, are brought by rail and canal to the mills, and elevated by electrically operated cranes to the spacious warehouses. The mills cover an area of 11 acres, and have a floor area of 30 acres. The process of manufacture carried on are complete in every detail from the sorting and combing of the raw material to the dyeing and finishing of the textile fabrics which are sent out ready to be made into garments. Mohair, cashmere, camel hair and worsted yarns are manufactured and sold for weaving, hosiery and other purposes, but the main production of yarns is woven into cloths for which the company is so well known. In May, 1918, the company received the honour of a visit by the King and Queen, and their majesties were deeply interested in the exhibition of fabrics displayed in the cloth warehouse. The mills are situated among open and pleasant surroundings, and the view from some of the upper floors compels the wish that more of our industrial undertakings could be established in equally charming spots.

Power Production.

The production and distribution of power from the engine room to the several floors of a textile mill forms a problem of some complexity. Power transmission is effected both by steam and electricity. In the East and West Mills the machinery is driven by two 600 h.p. vertical compound engines, whilst electric power provided by a 1,000 kw. turbine is employed to operate the machinery in the other portions of the building. The drives from the engine flywheels are by means of ropes to the various floor levels. Until 1915 the whole of the mills were run by steam, there being in addition to the large sets a number of small engines distributing over the building in accordance with requirements.

New and extensive buildings were erected in 1914, and it was then decided to install an electrical plant for running the machinery in these portions, and at the same time to convert some of the other portions from steam to electric drive. As stated, the electric power is obtained chiefly from a 1,000 kw. alternator, and this running at 1,000 revs. per min. provides three-phase current at 440 volts. Steam is supplied from Lancashire boilers, which work at a pressure of 140 lb. per square inch. A main switchboard controls all the departments.

In addition to the turbine there are two 250 kw. alternators, rope-driven from the main engines, the necessary power for these having been largely provided by changes and improvements effected in the driving of parts of the mill machinery. Distribution is by means of lead-covered feeders, terminating at suitable points in "Fluvent" fuse boxes. The motors are of the squirrel-cage type, and vary from 150 h.p. down to quite small sizes. One of the 100 h.p. motors drives high speed shafting at 850 revs. per min. In the weaving shed the looms of which there are several hundred, are driven by motors fixed in the basement, each motor operating three lines of shafting with their looms. This has proved an excellent arrangement, the motors themselves "being in an area set apart," whilst the absence of overhead belting, &c., in the weaving shed renders it very light and airy.

It is very interesting to find that notwithstanding all that has been written and said in support of the individual drive, the opinion at these mills is, after experience of both methods, in favour of group driving, and in this instance the results are certainly very satisfactory.

The lighting is provided by some 5,000 lamps, the current being transformed to 115 volts through Scott connected transformers. For stand by service a special high-tension cable is run from the generating station of the Shipley U.D. Council.

The present electrical plant having proved so satisfactory from every point of view, an order has been placed for 2,500 kw. turbo-alternator, and when this is in service the present large engines will be closed down. The whole of the conversion has been effected by the engineering staff of the mills, and the sound lines on which the work has been carried out reflects much credit on all concerned.

One feature which should not be overlooked by visitors is the village adjacent to the mills. Although not, perhaps, quite on the lines of a modern garden city or village, it was for very many years quite the only thing of its kind in the country, and from far and near came visitors to inspect the model village of Saltaire. It is safe to venture, however, that whatever points the model village of the immediate future may possess it will not have the solid buildings and architecture which form so prominent a feature of the cottages of Saltaire.

Our thanks are due to Sir Titus Salt, Bart., & Sons, Ltd., and to Mr. J. Stringer, the chief engineer, for assistance in the preparation of these notes.

Linking-up in Yorkshire.

At the present time we are fast getting away from the parochial idea of electricity supply and are making arrangements for providing facilities for cheap and abundant supplies of power over large areas. There are certain districts in the country which are particularly favourable for this and where large developments in the electric power load may be expected at an early date. As might be expected, this development is most likely to occur in areas which are already well supplied with electric power. This, in itself, introduces complications, as the supply is, of course, now being carried out in the old parochial way, but we are glad to see that the question is being carefully considered and that the various authorities are coming together in a conciliatory spirit and discussing schemes for linking-up so that electric power supplied in the most economical fashion will be an accomplished fact.

Those who attend the I.M.E.A. Convention at Bradford next week will find that this question is one to which the engineers in the West Riding are giving particular attention, and the map which we publish herewith will, therefore, give them some idea of the geography of the situation.

As will be remembered, this question of linking-up in the West Riding was the subject of a report by a Committee formed in 1916, which report we dealt with in The Electrician of July 18, 1919.

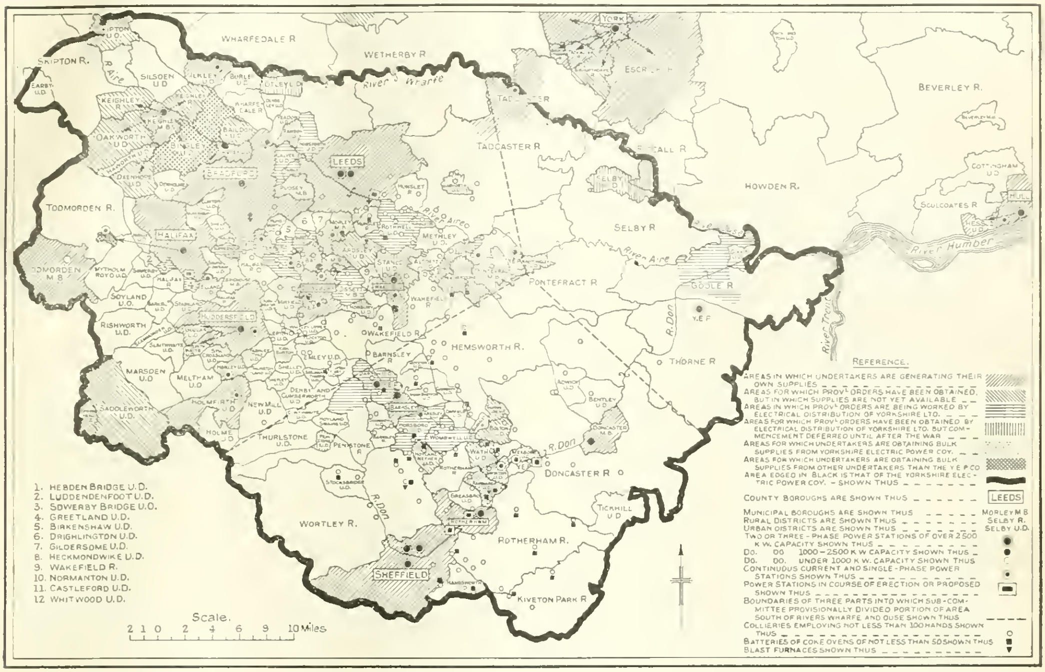
The area in question is divided into northern, southern and eastern sections. The northern section includes Bradford, Dewsbury, Halifax, Huddersfield, Leeds, Wakefield, and part of the district served by the Yorkshire Electric Power Company. The southern section includes Barnsley, Mexborough, Rotherham, Sheffield, and a further district served by the Yorkshire Electric Power Company. The eastern section is chiefly supplied by the Yorkshire Electric Power Company alone.

In the northern section interlinking is already in existence between Bradford Corporation and the systems of the Yorkshire Electric Power Company and the Shipley Urban District Council. It is estimated that the total maximum demand in 10 years' time in this area will be about 400,000 kw. Existing stations might be profitably extended to supply an additional 70,000 kw., so that approximately about 250,000 kw will have to be provided by further plant. Reference to the map will show that various sites for new stations have been suggested and we understand that the whole question is shortly to be considered by the Electricity Commissioners.

It will be noted that the district forms practically an ideal area for linking-up of this kind and for mutual assistance between already existing undertakings. A peculiar point is the way in which areas at present supplied by one undertaking are sometimes almost completely surrounded by areas supplied by another undertaking often from a station some distance away. From the point of view of efficiency such an arrangement requires modification.

In the southern section linking-up is in existence between the Yorkshire Electric Power Company, Sheffield Corporation and Rotherham Corporation, and between the Yorkshire Electric Power Company and the Mexborough Urban District Council. In this area it is thought that in another 10 years' time another 300,000 kw. will be required, and no existing station at present in operation in this section is capable of a much further efficient extension. Here, again, sites have been suggested for further large stations.

The eastern section is at present electrically very much less developed than the other two, though with the proposed opening of coalfields in this area it will probably not be long before it assumes some importance. The conclusion reached by the Committee was that a central authority was necessary to encourage linking-up, to decide on routes, charges and other similar questions. Problems connected with the position and size of generating stations would also come under their control though they would not own or operate stations for themselves. As we have said above the whole question is shortly to be considered by the Electricity Commissioners, and we hope that they will come to a decision which will make the further development of electric power supply in this important area an actual fact. It is evident, however, that there is a tremendous amount of detail work to be done before really efficient operation is the order of the day.


WHARFEDALE R
WETHERBY R
River Wharfe
YORK
SKIPTON R.
SILSDEN U.D.
KEIGHLEY
OAKWORTH U.D.
BINGLEY
BAILDON
BRADFORD
LEEDS
TADCASTER R
BEVERLEY R.
HOWDEN R.
COTTINGHAM U.D.
HULL
SCULCOATES R
HESSLE U.D.
River Humber
TODMORDEN R.
HALIFAX
SELBY R
SELBY U.D.
River Aire
GOOLE R
PONTEFRACT R
TODMORDEN M.B.
SOYLAND U.D.
RISHWORTH U.D.
HUDDERSFIELD
WAKEFIELD R
HEMSWORTH R.
R. Don
Y.E.P.
THORNE R
River Trent
MARSDEN U.D.
MELTHAM U.D.
SADDLEWORTH U.D.
HOLMFIRTH U.D.
NEW MILL U.D.
HOLME U.D.
THURLSTONE U.D.
BARNSLEY R
PENISTONE R
STOCKSBRIDGE U.D.
DONCASTER R
TICKHILL U.D.
WORTLEY R.
ROTHERHAM R.
SHEFFIELD
KIVETON PARK R
1. HEBDEN BRIDGE U.D.
2. LUDDENDENFOOT U.D.
3. SOWERBY BRIDGE U.D.
4. GREETLAND U.D.
5. BIRKENSHAW U.D.
6. DRIGHLINGTON U.D.
7. GILDERSOME U.D.
8. HECKMONDWIKE U.D.
9. WAKEFIELD R.
10. NORMANTON U.D.
11. CASTLEFORD U.D.
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RURAL DISTRICTS ARE SHOWN THUS SELBY R.
URBAN DISTRICTS ARE SHOWN THUS SELBY U.D.
TWO OR THREE-PHASE POWER STATIONS OF OVER 2500 K.W. CAPACITY SHOWN THUS
DO. DO. 1000–2500 K.W. CAPACITY SHOWN THUS
DO. DO. UNDER 1000 K.W. CAPACITY SHOWN THUS
CONTINUOUS CURRENT AND SINGLE-PHASE POWER STATIONS SHOWN THUS
POWER STATIONS IN COURSE OF ERECTION OR PROPOSED SHOWN THUS
BOUNDARIES OF THREE PARTS INTO WHICH SUB-COMMITTEE PROVISIONALLY DIVIDED PORTION OF AREA SOUTH OF RIVERS WHARFE AND OUSE SHOWN THUS
COLLIERIES EMPLOYING NOT LESS THAN 100 HANDS SHOWN THUS
BATTERIES OF COKE OVENS OF NOT LESS THAN 50 SHOWN THUS
BLAST FURNACES SHOWN THUS

Map Showing "Linking Up" Committee's Proposals.

Correspondence.

STRAY LOSS IN TURBO ALTERNATORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It must come as something of a shock to those of your readers who have been concerning themselves with the investigation of stray load loss in turbo-alternators, to see the airy statement by Mr. Carr, in your issue of May 21, that the one and only cause of this great loss is tooth-pulsation effect. Quite a number of designers who have had the opportunity of carrying out investigations in alternators of different proportions and outputs, now have little doubt as to the cause and location of the greater part of the loss, but few would care to publish any statement until our knowledge in several directions is advanced. There is little difficulty in these days in ascertaining experimentally the degree of flux-pulsation, and such tests show that your contributor's dogmatic assertion is without foundation.

If your contributor's reasoning were sound, the stray loss would be much increased by slotting the rotor poles. It is quite usual to slot the poles, even with solid-forged rotors, either to give greater magnetic stability, or better ventilation, and tests show that such slotting does not influence stray loss to any measurable degree. Your contributor, further, seems to imagine that the only flux that matters passes through the unwound part of the rotor periphery. If he will examine a typical rotor flux curve, he will find that an important proportion of the whole flux flows through the rotor teeth, and in consequence, if his reasoning were sound, there would be considerable stray loss on open circuit, which is not the case.

The remarks on the relative merits of Stalloy and Lohys carry no conviction. The statement is made that tooth-pulsation gives a greater loss with Stalloy than with Lohys. Now, if we recall your contributor's contention that stray load loss is due wholly to tooth-pulsation, it follows that he claims that the core built with Stalloy would have an appreciably greater stray load loss than if built with Lohys. There is no foundation in fact for such a statement.

Your contributor makes a variety of statements with which turbo alternator designers could not agree, but they are dwarfed in importance, by the sweeping claim that tooth-pulsation accounts for all stray load loss in turbo alternators.—I am, &c.,

S. F. Barclay,
Ph.D., M.Inst.C.E.

Manchester, June 10.

TELENDURON.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of June 1, Mr. Geo. V. Twiss writes to find fault with a brochure we have recently issued dealing with "Telenduron" insulators.

Perhaps we have failed to make sufficiently clear that "Telenduron" is manufactured to different specifications to suit the special requirements of different articles. For "Telenduron" as used for telegraph and telephone insulators supplied by us to the G.P.O., we claim:—

1. That it is less brittle than porcelain.
2. That while ordinary commercial porcelain to some extent depends upon its glaze for its insulation, in the case of "Telenduron" the surface finish is of no importance.
3. That its electrical properties as substantiated by N.P.L. reports are ample for all ordinary low voltage requirements.

For high voltage transmission we manufacture "Telenduron" to other specifications to suit the special requirements of the Consulting Electrical Engineer.

"Telenduron" is more durable than porcelain. While, like porcelain, it does not incorporate vegetable and animal substances, but is made from "rocks of the earth itself"—to quote Mr Twiss, it also stands knocking about—which porcelain does not.—We are, &c.,

per pro Thomas De La Rue & Company, Ltd.,
H. C. Parker, A.M.I.E.E.,
Manager.

Walthamstow, E.17.
June 15.

MINING ROYALTIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The idea is gaining ground that the Government proposal to nationalise mining royalties will help to ease the way of the over-burdened tax-payer, in that coal will ultimately be reduced in price the profits at present accruing to the private royalty owners being eliminated. Upon consideration it will be seen that that idea is incorrect.

In the first place, the present royalty owners will have to be bought out, at enormous cost, the money being provided out of the country's already very depleted coffers. Secondly, the royalties will continue to be paid to the Government, without the State benefiting by that additional taxation on royalties which has hitherto been provided by the private royalty-owner. Thirdly, it will be absolutely necessary to set up yet another Government Department for the collection of the royalties. There is a still more important consideration.

We all know how the original Customs House duty on tobacco was, in the first place, a very small affair; we also know to what proportions it has since reached. Would not the same thing happen in the case of coal? The work of the Chancellor of the Exchequer will be exceedingly difficult for many years to come, and there is no doubt that he will frequently feel sorely tempted to avail himself of the means, ready to his hand, of increasing the revenue, by raising the royalty on coal.

I submit that a solution of the whole problem in regard to mining royalties is to be found in the Bill recently framed by Lord Gainford, which has now passed through the Lords and is shortly to be presented in the Commons. I am, &c.,

London, June 15.
T. Humble.

The Norwegian Ministry of Industry has worked out a new scheme for the erection of a large State-supported Iron and Steel Works at Narvik. Instead of subsidising six different mills, it is suggested that a State contribution should be given to one large plant at Narvik, such contribution to be in the form of a State guarantee for a loan of 16,000,000 kroner, or half the capital of the company. The Narvik Steel & Rolling Mill is planned on the lines of ordinary crushing furnaces, with the idea of a later electric production. An annual production of 169,000 tons of coke, 125,000 tons of pig iron, 125,000 tons of steel billets, 25,000 tons of phosphate and 95,000 tons of rolling products is aimed at.

The Incorporated Municipal Electrical Association.

The 25th Annual Convention of the Incorporated Municipal Electrical Association will be held at Bradford and Ilkley from Tuesday next, June 22, until Friday next, the 25th inst. In our Arrangements of the Week column we give the complete programme of the proceedings, and below an incomplete list of those who will probably be present. Acceptances are still coming in, so that on the score of attendance, and we expect in other ways, the Convention should be an entire success.

S. T. Allen (Wolverhampton)
L. B. Atkinson (Cable Makers' Association).
F. Ayton (Ipswich).
W. J. Bache (Cheltenham).
J. W. Beauchamp (Electrical Development Association).
A. J. Beckett (Bridlington).
J. A. Bell (Aberdeen).
Major H. Bell (Hull).
T. W. Bloxham (Belfast).
F. A. Bond (Battersea).
J. Horace Bowden (Poplar).
S. E. Britton (Chester).
J. K. Brydges (Eastbourne).
J. W. Burr (Swansea).
A. Q. Carnegie (C. A. Parsons & Co.)
H. J. Cash (Electrical Contractors' Association).
W. A. Chamen.
R. A. Chattock (Birmingham).
G. Seton Chisholm (Siemens Bros. & Co., Ltd.)
J. Christie (Brighton).
S. Clegg (Lincoln).
T. D. Clothier (Bootle).
E. Cross (Rotherham).
A. G. Deverill (Brush Electrical Engineering Co.).
H. Dickinson (Liverpool).
J. E. Edgecombe (E.L.M.A.).
H. Ellis (late Borough Electrical Engineer, Southampton).
S. E. Fedden (Sheffield).
S. Z. de Ferranti.
J. P. Gregory (British Thomson-Houston Co.).
C. Nelson Hefford (Leeds).
J. S. Highfield.
E. E. Hoadley (Maidstone).
H. L. Howard (General Electric Co.).
J. Snow Huddleston (Union Cable Co.).
P. V. Hunter (Callenders' Cable & Construction Co.).
G. W. Keats (Woolwich).
H. Tomlinson Lee (Wimbledon).
F. Lonsdale (Fraser & Chalmers).
W. L. Madgen (B. E. T.).
F. H. Masters (The Electrician).
H. E. Midgley (English Electric Co.).
G. C. Milnes (Lancaster).
R. B. Mitchell (Glasgow).
A. Nichols Moore (Newport).
F. H. Nalder (Nalder Bros. & Thompson).
F. A. Newington (Edinburgh).
G. W. Partridge (London Electric Supply Corporation).
S. L. Pearce (Manchester).
Ald. G. Pearson (Bristol).
N. W. Pragnell (C. A. Parsons & Co.).
P. J. Pringle (late Burton-on-Trent).
H. Faraday Proctor (Bristol).
F. W. Purse (W. Ham).
P. N. Rand (Metropolitan-Vickers Electric Co.).
W. Redman (Shipley).
Major H. Richardson (Dundee).
Capt. T. N. Riley (Western Electric Co.).
J. A. Robertson (Salford).
L. L. Robinson (Hackney).
I. V. Robinson (B. E. A. M. A.).
W. M. Rogerson (Halifax).
T. Roles (Bradford), *President.*
C. Newton Russell (Shoreditch).
R. H. Schofield (Ferranti, Ltd.).
W. M. Selvey.
J. Senior (Ilkley).
C. M. Shaw (Worcester).
Col. A. Sinclair (Swansea).
Sir John Snell.
J. W. Spark (West Hartlepool).
J. E. Tapper (Beckenham).
W. C. P. Tapper (Stepney).
W. H. Taylor (Johnson & Phillips).
Col. W. A. Vignoles (Great Grimsby).
W. E. Warrilow (The Electrician).
S. J. Watson (Bury).
B. Welbourn (British Insulated & Helsby Cables).
P. P. Wheelwright (Blackburn).
P. Wightman (Davenport Eng. Co.).
G. Wilkinson (Harrogate).
D. Wilson (Babcock & Wilcox).
W. J. H. Wood (Bolton).
W. B. Woodhouse (Yorkshire Elec. Power Co.).
C. H. Wordingham.
W. Wyld (Hampstead).

Lighting the Albert Hall.

The lighting arrangements of the Albert Hall have been modernised and the old flickering arc lamps, which in the past have distracted the attention and strained the eyes of music-loving audiences, have disappeared. The present lighting is provided by sixteen 1,000-watt Mazda half-watt type lamps in large Mazdalux metal reflectors. These units are fixed high up in the central dome, from which position they shed an intense illumination over the whole auditorium. The improvement in the illumination, as compared with that given by the arc lamps, is extraordinary, and is due, not to any increase in the light generated, but rather to its more effective distribution by means of the scientifically designed Mazdalux reflectors, and the audience are able to read their programmes and papers with perfect ease. In a place like the Albert Hall, where the lighting units are necessarily difficult to get at, the question of maintenance is of great importance. Obviously, the new method of illumination is vastly superior to the arc lamps in this respect. The half-watt lamps need no attention until the time arrives for replacement, and with the vitreous enamelled Mazdalux reflectors used the amount of cleaning required is reduced to the absolute minimum. The installation exemplifies a method of lighting which might be effectively employed in any large glass-domed interior of similar nature.

Legal Intelligence.

British Thomson-Houston Company v. Duram, Ltd.

Last week Mr. Justice Astbury heard a summons taken out by plaintiffs in this action for alleged infringement of their patent for the manufacture of tungsten filaments. The validity of the patent is denied, and the infringement is put in issue. The summons was for liberty for plaintiffs, by their general managers and scientific witnesses, to enter defendants' works at Hanwell, and to inspect work and examine the process used by defendants for the manufacture of their drawn tungsten wire. Defendants opposed inspection, and set up a secret process.

His Lordship said the circumstances under which inspection ought to be ordered and the safeguards which ought to be imposed required to be carefully considered. He was not prepared to accept entirely the view expressed in the expert evidence submitted. Plaintiffs' specification was a long and intricate one, and apparently was for an improvement in certain earlier processes in patents of 1906 and 1907, and there were five claims. He had suggested that before deciding whether inspection was necessary defendants should answer a series of interrogatories to be delivered by plaintiffs, with the object of asking defendants as to each step which, in their judgment, was indicated and protected by their own letters patent. This defendants had offered to accept, and they had also offered to give a full admission that they produced their tungsten rods under heat, and that the rod was drawn down by successive stages to the finest wire. Having regard to defendants' willingness to answer questions which plaintiffs would be permitted to frame, he allowed the summons to stand over until after he had seen the defendants' answers.

Nuisance by Electricity Works.

Last week Mr. Justice P. O. Lawrence heard an action by Mr. Morrow against Stepney Borough Council for an injunction to restrain an alleged nuisance by their electricity works. Plaintiff, who was owner and occupier of a workshop and also lessee and occupier of other premises in Brightlingsea-place (leased from defendants), alleged that the electricity supply station of defendants in Narrow-street (opposite plaintiff's premises) and their plant, which had been in existence since 1909, were causing a nuisance, particularly when the wind was north-westerly or south-westerly, by the constant discharge of gritty dust and ashes. This discharge choked the gutters and roof, the pipes and gullies of plaintiff's premises, and when rain fell it flooded his premises, and the dust and grit formed a thick deposit on the timber on his premises and got into the natural cracks in the timber and blunted the edges of tools.

Defendants denied that any nuisance had been caused or that plaintiff had suffered any damage by reason of anything which had been done by them. They also pleaded that the electrical works formed part of their statutory undertakings for supplying electric light and power, and that prevailing conditions were making the carrying on of such undertakings difficult, particularly owing to the inferior quality of the coal obtained and the short supply of labour. While not admitting any liability, defendants paid into Court £100 in satisfaction of all claims.

After hearing evidence and legal arguments, his Lordship said he accepted the testimony of plaintiff and his witnesses. It had been proved to his satisfaction that the effect of the grit and ashes from defendants' chimneys deposited on his premises was to block the gutters and stack pipes on his workshop and to cause the premises to be flooded when it rained. Secondly, the gritty deposit penetrated the cracks in the timber in his yard, with the result that when he worked at the timber the edge of his tools was blunted. Lastly, his dwelling-house was rendered so uncomfortable by the gritty dust and ashes which fell on the beds and clothing that he was justified in moving to another house. The evidence satisfied him beyond doubt that the discharge from the chimneys of defendants' works had rendered plaintiff's premises less suitable for business and residence, having regard to the locality, than they were. In one sense there had been some delay, but it was to the credit of the plaintiff that he had not taken steps to stop the nuisance until it became intolerable. No exceptional circumstances had been proved by defendants to induce him to exercise his discretion to award damages in lieu of an injunction. The plaintiff was, therefore, entitled to an injunction, which would be suspended until Nov. 12 next to give defendants time to abate the nuisance. No special damages had been proved, but he was justified in granting plaintiff £50 as general damages for the discomfort which he had suffered and the costs of the action.

On Tuesday Mr. Justice Eve sanctioned a scheme for the realisation of the assets or the reorganisation of the Buenos Ayres Port and City Tramways Company, Ltd.

Union v. Non-Union Labour.

We learn that at a meeting of the District Council for Area No. 10 (Greater London) for the Electricity Supply Industry, the question of connecting up jobs or work done by non-union labour to the supply undertakings' mains was discussed at length. No agreement was reached, but the Employees' Side unanimously decided that "on and after July 1 instructions should be issued to their members that they are not to connect up any jobs or work done by non-union labour or scab labour in the area covered by the Council." We are also informed that the various executives of the Unions concerned have been asked to permit the Union men to cease work on July 1 against any or all non-union labour employed on any electricity undertaking in the area.

Commercial Topics.

German Debts.

The Controller of the Clearing Office (Enemy Debts) warns the public that attempts are being made by German agents or principals to obtain direct settlement or payment of their pre-war debts from British debtors. By the terms of the Treaty of Peace Order, 1919, it is unlawful for any person to pay, or to accept payment of, a debt coming within the provisions of Article 296 of the Treaty of Versailles. Persons to whom overtures have been, or may be, made for settlement of pre-war debts, except through the Clearing Office, are requested to communicate full particulars to the Secretary of the Clearing Office (Enemy Debts), Cornwall-House, Stamford-street, London, S.E. 1. British claims to the number 34,802 were on the 15th ult. notified to the German Clearing Office, and a further large number will be notified during the present month. As soon as notification of the admission of these claims has been received from the German Clearing office payment will be made by the Controller without further request by the British creditor.

* * * *

Domestic Electricity Supply in America.

Recent statistics show a rapid advance in the use of electricity for lighting and domestic purposes in the United States. From the "Electrical World" of May 15 we learn that over 33,000,000 Americans, or nearly 31 per cent. of the people, lived in electrically-lighted homes on Jan. 1, 1919; about 6,300,000 houses were wired, and there were 340,000 farm-lighting plants. The figures are based upon a study of the details of electric service in more than 10,000 cities and towns and the surrounding country districts as given in McGraw's Central Station Directory. The central stations of the county only cover territory with a population of 62,000,000 (or 57 per cent. of the total) so that 55·8 per cent. of those within reach of an electric service enjoy the advantages of electricity supply. In 1915 it was estimated that not more than 10 per cent. of the residences in the states were receiving a supply from power stations. In California 79 per cent. of the houses are wired; in Utah 74·4, and in the Central States 48 per cent., but in Mississipi the percentage is only 8·4 per cent. It is stated that the value of an electric service is now so generally recognised that 98 per cent. of new houses in cities and towns are wired.

The rapid progress made in America is due to the organised propaganda carried on not only by supply companies, which indulge in periodical campaigns for "home wiring" and the sale of heating and cooking appliances, but to the organised propaganda of the National Electric Light Association and kindred societies which have done much to educate people to know and appreciate the benefits of electricity in domestic service. There are indications that this campaign is to be intensified in order that all new houses as well as many of the existing farm buildings may be connected to the supply stations. American methods may not succeed in this country, but we think that the time has come when a more intensive, better co-ordinated attempt for the development of electricity supply might be made in this country. In such an attempt the electrical Development Association, the I.M.E.A., the supply companies, electrical manufacturers and contractors should co-operate. Much progress has been made in electric power applications during the war, but we believe that there should now be some concerted scheme for giving a much greater fillip to the domestic applications of electricity, such as heating, cooking, &c.

* * * *

Import of Rubber-Covered Wire into Australia.

Some time ago we referred to the Proclamation of the Commonwealth Government, of April 2, 1919, prohibiting the import of rubber-covered wire into Australia except on certain stringent conditions. Though it was originally intended that the Proclamation should operate as from July 1, 1919, it was not actually enforced until April 1, 1920. We now learn that since the date of the Proclamation the Commonwealth authorities have decided to accept compliance with the undermentioned conditions as a satisfactory alternative to compliance with the corresponding conditions specified in the Proclamation, viz.:—

(1) The insertion of a tape marked as required between the vulcanised tape and outer covering will be accepted in lieu of marking on the tape.

(2) The requirements laid down in the British Engineering Standards Association (Report No. 7 of 1919, revised July 1919) will be accepted for the respective grades of cable.

We are informed that rubber-covered wire, purchased from the Disposal Board, is being exported to Australia not marked as required by the Proclamation, and the High Commissioner for Australia has been asked by the Commonwealth Department of Trade and Customs to give publicity to the fact that it is not proposed to exempt such wire from the requirements in question.

It is natural that the Commonwealth Government should desire to exclude inferior material, but, as we pointed out at the time, the original conditions were so exacting that the export of rubber covered wires and cables from this country would be greatly affected, and we are glad, that more satisfactory and more reasonable alternative requirements have been adopted. The original conditions demanded that on each coil there should be a label giving the manufacturer's name and address, the length of the wire, date of manufacture, gauge of conductor and insulation resistance per statute mile. In addition, v.i.r. insulated electric conductors up to and including 19 12 standard wire gauge, classifiable as 600 or 2,500 megohm grade, should have the grade indelibly and legibly applied to the wire at least once every yard, and should comply with other requirements and tests.

Electricity Supply.

Kettering Urban Council has received sanction to borrow £9,284 for additional plant at the electricity works.

The Peterborough Cathedral Restoration Committee propose to spend £2,200 on the Electric Lighting of the Cathedral.

The "London Gazette" contains an announcement that the Electricity Commissioners intend to make Rules for Applications for Special Orders under the Electricity (Supply) Act, 1919, the publication of notices and advertisements, &c.

Market Drayton Urban Council has invited the local electric light company to tender for supplying current and maintaining 80 (or 108) electric lamps during the lighting season.

Leighton Buzzard Corporation wish to obtain a supply of electricity from Luton, and failing this an attempt will be made to induce Dunstable Corporation to co-operate in a joint undertaking to supply the two towns.

Newton Abbot Council has invited the local Electric Light Company to submit terms for the public lighting for a period of two or three years, substituting 500 c.p. metal filaments lamps for the arc lamps.

Colne Corporation has increased the charge for electricity for lighting from 4½d., plus 75 per cent., to 8d. per unit ; for power from 85 per cent. to 95 per cent. ; and for heating from 75 per cent. to 85 per cent., on the scale charge of 1¼d.

During the past year the Leith Dock Commission has expended £14,786 on electric and hand cranes, £12,000 on extensions of the electric power station and electric cables, and £9,000 for portable grain-discharging appliances.

Liskeard Town Council has informed Messrs. W. G. Heath & Company, of Plymouth, that they can erect standards and overhead wires for the purpose of electricity supply in the borough, but consent must not be taken as giving them the exclusive right to install electric light.

The total income of the Plymouth Corporation Electricity undertaking for the year ended March 31 was £92,957, and, after meeting expenditure, the gross profit was £23,172. After payment of capital charges and income tax the net profit was £274, against £2,000 in 1918-19.

A public meeting of Dungarvan ratepayers has expressed approval of an electric supply scheme. A company is to be formed with a capital of £10,000, and the water-power of the river Colligan is to be utilised in the generation of electrical energy.

The Minister of Transport has extended to Sept. 30, 1920, the time within which the Deal & Walmer Electricity Company are required to lay mains in the parish of Ringwould, and in streets and parts of streets in Deal and Walmer mentioned in the second schedule of the Deal and Walmer Electricity Act, 1914.

Cardiff Tramways and Electricity Committee has decided to increase the charges for electric current for lighting by 15 per cent. from September next in order to meet the increased costs arising from increased wages and the recent advance in the price of coal. The new increase will make the charges 90 per cent. above pre-war figures.

A West London suburban joint electricity or linking-up scheme is being considered by the electrical engineers of the Corporations of Ealing, Wimbledon and Kingston-on-Thames and of the Urban Council of Barnes. A preliminary conference was held at Barnes when the desirability of co-operation was acknowledged, but the technical details are to be worked out by the engineers.

Hessle Urban and Sculcoates Rural Councils are anxious to obtain a supply of electricity from Hull Corporation, and several houses have already been wired. A main will be laid to the new Portland cement works at Melton, a supply will be given along the route. Negotiations are proceeding between the authorities as to the terms upon which supply will be made available in Hessle.

Although there was a deficit of £989 on the past year's working of the Accrington electricity department the position is very satisfactory according to Ald. Higham, chairman of the Electricity Committee. It was now costing between £15 and £30 to connect services, and the amount spent on meters and services during the year was close on £20,000, The charges for electricity are to be increased by 5 per cent., with the exception of those customers subject to the sliding scale.

Several towns and villages in Cumberland are anxious to obtain a supply of electricity from Carlisle Corporation. The chairman of the Urban Council of Wigton, over 11 miles distant, has reported that Carlisle will be in a position to supply Wigton and other places. It is proposed to erect overhead poles and wires by way of Cummersdale and Dalston, tap various villages on theroute, and then continue westward to Aspatria.

Turton Council, which is taking a supply of electricity in bulk from the Lancashire Electric Power Company, has provisionally adopted the Company's scheme for an extension of the existing undertaking. This provides for four distinct areas, which, whilst complete in themselves, would be linked together for mutual advantage. The estimated cost for the four areas is : Bradshaw, £5,300 ; Egerton, £6,015 ; Horrobin, £300 ; and Edgworth, £6,240 ; a total of £17,855. Application has been made for power to borrow £20,000 for the scheme.

The accounts of the Ordnance Factories for the year ended March 31, 1919, have been issued and the Comptroller and Auditor-General reports that the cost of generating Electricity at Woolwich Arsenal compared unfavourably with the cost of current purchased from the local corporations. The principal justification for the maintenance of the Arsenal plant during the war was that it served as a valuable standby against frequent interruptions of outside supply, and that it had been under consideration to shut down the plant as soon as the outside supply was properly safeguarded.

The revenue of the Marylebone (London) Electricity undertaking for the year ended March 31 was £280,016 (compared with £221,966 in previous year) and gross profit £133,066 (£110,149). Interest and special charges required £63,320 (£65,558) and repayment of loans £46,634 (£45,894), leaving net surplus £23,112 (compared with a deficit of £10,03). Average price charged was 3·433d. (3·248d.) per unit ; total working costs were 1·798d. (1·712d.) and capital charges 1·334d. (1·646d.). Units generated were 26,631,963 (21,878,878) and sold 19,770,781 (16,245,133). Maximum load was 12,709 (9,485) kw. and the load factor 17·8 (19·6) per cent.

Ald Westhead recently retired from the chairmanship of the Stafford Gas and Electricity Committee. For the year ended March 31 the units sold were 1,999,200. The capacity of the plant is 1,176 kw., but plant of 2,600 kw. is now in course of installation. The total loans raised for electricity purposes amount to £48,750, of which £28,912 has been repaid. After debiting loan charges and income tax and crediting dividends and rents there was a net deficit of £302 on last year's working, which, added to £562 brought forward, made a total deficit of £864. A sum of £1,000 out of the gross profits of £3,818 had been placed to credit of depreciation fund.

On the suggestion of the Electricity Commissioners, Darwen Corporation are arranging for an additional supply of electricity from Blackburn. The cost of laying high pressure under ground mains from the Borough Boundary to the Electricity Works is estimated at £27,000. The Town Council have fixed the price of electricity for lighting at 8d. per unit net ; for power the charge will range from 5¼d. per unit up to 100 units, 1¾d. for 2,000 units ; and for domestic purposes 4½d. for the first 30 units, and 2½d. per unit in excess of this quantity. The Corporation has made arrangements for the supply of energy to the Darwen Spinning Co., and sanction is being sought to a loan of £27,145 for mains extensions.

It is surprising to find at this time of day a body of business men, such as the members of the Sheffield Corporation, endorsing a proposition that "the charges for electric lighting should be on the same basis as the charges for power." This was the effect of an amendment to a recommendation of the Electric Supply Committee, that, in view of extra costs (£27,498 in wages, £59,998 coal and carting, and £7,500 for interest), an increased scale of charges for lighting, power and traction should be introduced.

Councillor Graves, who moved the amendment, said that the municipality was supplying the same article to everybody, and the charge should be the same. Some of it was charged to big manufacturers at 1d. a unit and some to others at 5d. The cost of production was the same ; only the bill to the consumer was different. The undertaking was started in order to benefit the citizens by supplying electric light. He cited some anomalies in the charges, and he urged that the householder, who helped to equalise the load, should be encouraged in the public interest to burn electric light instead of the less healthy gas.

Ald. Styring said they all liked the idea of having the light cheaper in their houses, but the reason for the charges being higher was that whereas one class of consumer used the light for an hour or so the power users needed it for 9 to 10 hours. For lighting consumers a certain part of the plant had to be provided and kept always ready for use at any time. It followed that for a considerable portion of the day the plant which was used for that purpose was unproductive. When the light was used for 4½ hours a day the charge was reduced from 4d. to 2d., and for 9 hours from 4d. to 1d. Taking the whole supply they only got a rate of 2·3d. for the current which was supplied for lighting. Even under present conditions the price paid by the power consumer allowed the citizen to get his light much cheaper than he otherwise would. There was no place in the country where differential rates were not in force and were not regarded as a reasonable business proposition. He also pointed out that, whereas gas had risen 200 per cent., electric light had increased only 50 per cent. Again, the power consumer was being asked to pay 105 per cent. against the light consumer's 50 per cent.

Notwithstanding the arguments of Ald. Styring and of Ald. A. J. Hobson, who remarked that Councillor Graves was too astute a business man not to know that he was throwing dust in the eyes of the public by his proposal, the amendment was carried by 24 votes to 21. It is arguments such as those used by certain members at the last meeting of Sheffield Corporation which make people doubt the wisdom of entrusting the control of electricity supply to local authorities.

Business Items, &c.

Having purchased a freehold site, Mr. A. Goldie Engholm, electrical engineer and manufacturer, has transferred his offices and warehouse to 44, Severn-street, Birmingham, close to New-street Station.

Mr. J. G. Royce, of 37, Victoria-street, Bristol, has been appointed by The Hart Accumulator Company, Ltd., as their agent for the sale of the "Hart" storage battery in the south-west district of England. This agency covers the counties of Gloucester, Somerset, Devon, Cornwall and Dorset.

Messrs. Tofield & Robinson, Ltd., 165, Edmund-street, Birmingham, have recently purchased the Birmingham business of Messrs. Handley & Robinson, Ltd., and have also acquired offices and stores in London. In addition to the ordinary business of contracting engineers the new firm will stock a large range of Alternating current and direct current motors for immediate delivery.

Electric Traction.

As there is an estimated deficit of £11,000 on the year's working of the Burton-on-Trent tramways the minimum fare has been raised from 1d. to 1½d.

Sunderland Tramways Committee is converting 12 of the existing tramcars into vestibule cars with top-deck covers, and 12 new cars of a similar pattern are on order.

Heywood Corporation tramways department has made a loss of £513 on the past 12 months, compared with a profit in the previous year of £944. The total adverse balance is now £1,894.

The report of Nottingham Tramways Committee (adopted at last week's Council meeting) states that during the year ended March 31 receipts were £378,948 (increase £90,308) and working expenses £294,224 (increase £90,308). The gross profit was £84,724 (against £103,988). Interest required £16,169, and repayment of capital £24,286, and of the remainder (£44,269) a sum of £18,269 has been placed to reserve and renewals, £2,000 to accidents reserve and £24,000 applied in aid of rates. Passengers carried were 58,749,654 (compared with 46,415,421) and car-miles run 4,088,570 (increase 70,935).

In connection with the scheme for the extended use of Electric Traction on the North-Eastern Railway, some interesting experiments were carried out last week in high-speed running with the third rail. The York and Scarborough line between Strensall and Flaxton was selected and the object was to afford the railway engineers and operating staffs information as to the possibility of electric locomotives engaging the rail accurately at high speeds at the points at which the rails are interrupted for level crossings and other causes. On the York-Newcastle section trains travel at 60 miles an hour or more, and as there was no English experience of the behaviour of the "shoe" at these speeds, about three-quarters of a mile of the line, intersecting Strensall Common, was equipped with a third rail. The length selected was divided into several sections, the intervals varying in length, up to 40 ft., to represent the intervals in the third rail which will be necessary for level crossings, &c. Two powerful locomotives were each fitted with a different type of shoe, and were run at increasingly high speeds over the section to ascertain whether the shoes would properly "engage" on the rail after a railless section, or whether they would fail to fit, or possibly would collide with the rail, or other contingencies arise. It is stated that the results proved perfectly satisfactory. All electric locomotives to be used on the main line when equipped will be dual fitted with both shoes and bows, it being the intention that all long crossings, shunting yards and stations shall have the overhead equipment. The bows will be utilised for restarting after a stoppage at the end of a section, though when running full speed the momentum of the train will carry it over interruptions on to the next "live" section.

It is proposed to substitute the overhead for the Lorain surface contact system of traction , the Wolverhampton Corporation system. Among the reasons given for the proposed change are the heavy operating costs of the Lorain system, the avoidance of irritating delays due to frequent breakdowns, the necessity of double tracking, the age of the track, which in most parts is worn and sunken, the free interchange of traffic between one town and another. The Lorain system was adopted in 1900, but the Tramways Committee are convinced that the decision to adopt it was not a mistake. The construction of electricallly-operated tramways was then in its infancy, and although more expensive than the overhead trolley, it avoided the use of poles and overhead wires. Although the Lorain system had been successfully operated and the total working costs were less than most other tramways in the United Kingdom, it is imperative to consider other factors. The growth of traffic in Wolverhampton has made double tracks necessary; the cost of a double track with overhead equipment is the same as single track, whereas with the Lorain system double tracks mean double the cost. There is also urgent need for through communication with Walsall and Dudley, and as these are overhead lines it is desirable that Wolverhampton should run through on one system only. Moreover, if the tramways of the Black Country tackled goods traffic on an extensive scale, Wolverhampton would be somewhat isolated. The committee state that the estimated life of the Lorain system has been exceeded, but the useful life of the rails could be prolonged if overhead poles could be erected without delay. In addition, the Lorain meant less reliability of service than the overhead system. The Lorain construction necessitated the adoption of special-sized wheels and tyres, motors and other equipment which, in future years, would mean extra cost as the Engineering Standards Committee was now active in standardising tramway equipment.

Mr. Alfred Baker, manager of Birmingham Corporation Tramways, who has reported on the subject, states that the doubling of a single line of overhead tramway is a comparatively simple matter, as temporary tracks can be laid on the street surface over which the cars can run while reconstruction of the old track takes place. But with the surface contact system this is impossible, and there is no practicable alternative other than closing down the tramway traffic while the work is in progress. According to the Borough Surveyor's estimates the cost of conversion, after allowing for the sale of old materials, will be £375,000, viz., overhead equipment, £50,000; relaying 20 miles of track, £520,000; eight miles of extra paving, £12,000; special work, £14,000, less £21,000 for old materials. The estimated saving with the overhead system, when running 1,200,000 car-miles per annum, will be £5,830, and, in addition, there will be a saving of £10,500 if the overhead system, instead of running the Lorain and equipping new tracks with the system, is adopted.

The Council decided on Monday to approve the conversion and to appoint a temporary assistant to the tramways Engineer.

Imperial and Foreign Notes.

The Mornington (Victoria) Shire Council has commissioned Messrs. Christie & Gardiner, of Melbourne, to prepare a report on a scheme for electricity supply in the uown.

An order has been placed with Messrs. Boving & Company, Ltd., for four 5,600-h.p. turbines by the Mysore Government for the Cauvery River scheme. These will be, we believe, the largest Francis turbines built in this country, though Pelton wheels up to 8,000 h.p. have been built here, five of this size being supplied by Messrs. Boving & Company to the Tasmanian Government. The turbines will be of the single discharge spiral type for a head of 415 ft. and will run at 500 revs. per min. In addition, two Pelton wheels of 450 h.p. are required for driving the exciters. These new units form the first group of the large machines which are to replace the existing smaller machines in order to utilise better the power available.

A sum of £17,527,000 is to be raised this year for hydro-electric purposes by the Ontario Government, including $10,500,000 for plant at Chippewa. It is also proposed to develop 75,000 h.p. at Cameron's Falls on the Nipigon river, but only two 12,500 h.p. will be installed at present; the turbines are by the J. P. Morris Company, and the three-phase generators, which are rated at 10,600 k.v.a. at 80 per cent. power factor, are by the Canadian Westinghouse Company. Energy will be generated at 12,000 volts (60 cycles), and will be stepped up to 110,000 volts for transmission to Port Arthur and Fort William.

The purchase of the Brisbane tramways by the State of Queensland was referred to at the recent meeting of the Brisbane Electric Tramways & Investment Company, Ltd., by Mr. H. R. Beeton, who said that the Act had received the Royal assent. The Act provided that at any time on or after Sept. 29, 1920, the tramway should, from a day summarily specified by the Commissioner of Railways, vest in the Queensland Government, at a price to be settled afterwards, and inasmuch as failing agreement, the price had to be determined by the Land Court, or on appeal by some Court of Superior Jurisdiction, considerable time was likely to elapse before payment was made, which, in view of the company's liability on its debentures, was a great hardship. No compensation was to be allowed in respect of any material for, or business of, supplying electric light, or for any unauthorised lines. Payment may be made at the Government's option in cash or in Queensland Government 6 per cent. debentures having a currency of 21 years. Most of their electric light business had already been sold, and the company had very little material which was not used for tramway purposes. Even if some parts of the lines were found to have been technically unauthorised, which they were advised at the time they could not be, they were built for the public service with the consent of the local authorities concerned, and it would be most unfair to take them over without payment. The present situation was anxious and difficult; but, relying on the instinct of the British race for fair play, they hoped they would obtain eventually a fair price.

The Hungarian State Railway Authorities also propose to adopt electric traction on 868 miles of railway. The work will be carried out gradually over a period of nine years.

Over 400 miles of Austrian State Railway System in the Alpine districts are to be converted to electric traction at a cost of 3,500 million crowns. The existing hydro-electric works are to be extended, and new stations erected in order to provide the necessary electrical energy.

The United States Government have appointed a committee, headed by Mr. Alexander (Secretary of Commerce) and Admiral Benson (Shipping Board), to develop Commercial Relations with the South American Republics

It is announced by our contemporary, "Engineering," that it is proposed to organise a Chemikalisch-Technische Reichsanstalt, which will be analogous to the well-known Physikalisch-Technische Reichsanstalt of Berlin, and will work on lines somewhat similar to our Department of Chemical Technology at South Kensington. Among the main objects of the new institute are investigations of raw materials and of substitutes for raw materials, the utilisation of by-products, and the standardisation of tests; safety in mines, testing of masks and other apparatus, research on spontaneous ignition, &c. Rust prevention and the influences of cold and high altitude on certain materials are among the problems for immediate research. The staff of the Military Experimental Station, which has collected a good deal of information during the thirty years of its existence will form a nucleus of the new staff.

The Fiat Motor Works at Turin are said to be one of the biggest motor factories in the world where no coal is used. For power and lighting the daily consumption is 15,000 kw., and when the new steel works and forges were erected they were designed to be operated entirely by electricity secured from water power. Our contemporary "Engineering" states that soon after the company bought up the Piedmontese steel works and forges, in 1917, control was obtained of the Mont Cenis Hydraulic Power Company. The plant existing at that time on the Cenischia River was able to supply 65,000,000 units, of which 38,000,000 units were available in summer and 27,000,000 units during the winter months. This amount of current will be considerably increased in the near future, extensive works being now carried out on the Cenischia River. In addition to this, by increasing the size of the natural lake on the Mont Cenis, the current available will be increased to 200,000,000 units, of which a very large quantity will be available during the winter months. When these extensions have been completed, the whole of the electric current produced by the Mont Cenis Company will be reserved for the Fiat motor works.

Telegraph and Telephone Notes.

A serious strike of marine wireless operators started on Tuesday owing to a dispute as to wages. The strike was called by the Association of Wireless Telegraphists, which is said to represent about 4,500 wireless operators. Mr Godfrey Isaacs, managing director of the Marconi Wireless Company, states that all the company's servants are under agreement to give four weeks' notice and that the Company will hold them to the terms of their agreement.

Two of the nine directional wireless stations in the United Kingdom manned by the Royal Navy will be closed from midnight on June 14-15 to midnight on July 14-15 to allow of a series of wireless experiments being carried out by the cruiser Antrim, the instructional ship attached to the Portsmouth Signal and Wireless School, with the stations at the Lizard and Carnsore, in regard to which several reports have lately been received that the bearings given have proved incorrect.

Particulars of the progress made with the extension of the telephone service in farming districts were given by the Postmaster-General (Mr Illingworth) in the House of Commons last week. He said the rural party line service was still in operation, and additional subscribers were accepted subject to payment of the usual £4 surcharge in the first year, unless a considerable amount of work was involved. During the past 12 months over 500 new call offices had been approved in rural districts and some of them would be of benefit to farmers. When more progress had been made in overtaking the arrears of work it might be possible more freely to extend telephone facilities in rural areas.

Some particulars have been published of the new Radio-Telegraph Scheme of the French Government for supplementing the present telegraph and submarine cable system of communication. The projected scheme will be developed in four sections. The first, which aims at providing communication between ships at sea and coastal towns, is already in existence and working satisfactory, but extensions will be made. The second section will at the outset be used to maintain regular communication with the mountainous regions which, during the winter, are cut off owing to the weight of snow having brought down the wires. A coastal system will ensure communication between the mainland and the principal islands round the coast, and, finally it is hoped to link up Algeria with Paris. The third, or Franco-European system has been started, wireless communication having been established since May 20 with Hungary, and it is hoped shortly to open up wireless communication with Belgrade. The station at La Doua near Lyons, which is using the Poulsen system and has for some time past been in communication with the United States, will shortly be available for the transmission of commercial messages, and the new station at Croix d'Hins, near Bordeaux, is also intended for commercial communication with Tuckerton, New Jersey. The fourth section provides for linking up the French Colonies, including Saigon, Noumea and Tahiti, with France. The distance from Paris to Saigon is 6,200 miles, and that from Saigon to Tahiti 6,800 miles, or 7,300 miles by way of Noumea. Stations capable of transmitting messages 7,500 miles will be erected at Paris, Saigon and Tahiti, and less powerful stations, of about 4,300 miles range, will be constructed at Jibouti, Antananarivo, Noumea and Martinique. Still smaller stations will link up the French possessions in Africa, connect Martinique with French Guinea, and Saigon with Pondichery. The Ministry of War has already begun the construction of stations at Suida, Bamako and Brazzaville (French Congo), Antananarivo and Saigon.

Institution Notes.

At the Batti-Wallahs' Luncheon on the 21st inst. at the Holborn Restaurant, Mr. Guy Campbell will speak on his recent trip to the United States of America.

The subject of connecting rod bolts was further discussed at the last meeting of the Diesel Engine Users' Association. Mr. J. L. Chaloner, Mr. Geoffrey Porter and Mr. G. W. F. Horner took part in the discussion, and an interesting communication was read from Mr. Charles Day in which he gave the results of investigations carried out by him at Stockport. The President (Mr. Charles Gould) announced that at the following meeting Mr. A. Abbott, of the Department of Scientific and Industrial Research, would address the members on the "General Scheme of the Research Association for Liquid Fuels"

At the recent annual conference of the Association of Teachers in Technical Institutions the President (Mr. E. L. Rhead) devoted his presidental address to the position and prospects of teachers in technical schools. He said that a technical teacher must be something more than an ordinary teacher. His knowledge of industry and industrial requirements must be acquired in a practical manner, and industry could as readily claim him as the teaching profession. To get the right type of man technical schools must compete with industry, and payment must be made accordingly. Technical teaching must not be made the strap-hanger of education, nor treated as an unwanted child. The advances that had come in the way of other teachers had not yet reached the technical teachers. An average of the advances might be taken approximately at 30 per cent.

The conference unanimously carried a resolution urging the immediate adoption of the scale of salaries in technical institutions as formulated by the association, and the immediate placing of every teacher on the scale at that point which he would have reached if the scale had been in operation over the whole of his teaching service. The scale of salaries for full-time teachers formulated by the association is: Assistants, £300 to £600 in 10 years; principal assistants, £400 to £700 in 10 years; heads of departments (three grades, according to work and responsibility) (*a*) £500 to £700 in five years; (*b*) £600 to £800 in five years; (*c*) £800 to £1,000 in four years.

Personal and Appointments.

Mr. F. C. Cheetham, of Sale, has been appointed mains superintendent at Weymouth.

Mr. W. N. Haworth, D.Sc., Ph.D., has been appointed professor of organic chemistry at Armstrong College, Newcastle-on Tyne.

Out of 29 applicants Mr. James Menzies, of Dundee, has been appointed manager of the Kilmarnock municipal tramways.

On Tuesday the honorary degree of D.Sc. was conferred by Cambridge University on Sir Joseph Thomson and Sir Joseph Larmor, M.P.

The Albert Medal of the Royal Society of Arts for 1920 has been awarded to Prof. A. A. Michelson, professor of physics in the University of Chicago.

Mr. R. McLeod has been appointed traffic superintendent of the Edinburgh tramways in succession to Mr. Young, who was recently appointed tramways manager at Dundee.

Mr. Lindesay Clark, general manager of the Briseis tin mines, in Tasmania, has been appointed consulting engineer to the Victorian Electricity Commission.

Sir John Cadman is resigning the Chair of Mining in the Birmingham University in order to take up the position of Adviser to the Government on questions affecting coal and petroleum.

Dr. W. E. S. Turner has been appointed to the new chair of glass technology and Mr. Joseph Husband, B.Sc., A.M.I.C.E., to the chair of civil engineering at Leeds University.

Mr. Wm. T. Tallent-Bateman, who, about a year ago, was appointed work's manager to Messrs. Dorman & Smith, Ltd., Ordsal Electrical Works, Manchester, has recently joined the board of directors, at the same time retaining the position of work's manager. Mr. Bateman was formerly chief switchgear engineer to the British Westinghouse Co.

Mr. Harry S. Ellis, who it will be remembered recently resigned his position as borough electrical engineer at Southampton, has joined his brother (Mr. Arthur Ellis) in consulting practice, and his future address will be 9, Park-place, Cardiff (head office), and 103, Cannon-street, London, E.C. The firm will specialise in electricity supply, tramways and transport, as well as Parliamentary work. During the past 20 years Mr. H. S. Ellis has had considerable experience, and prior to his Southampton appointment he held important positions at South Shields, Bradford and Cardiff, where he was closely identified with the application of electric and mechanical engineering in shipyards, textile mills, public supply and engineering undertakings. During the war Mr. Ellis held an honorary appointment as chief technical assistant to the Controller of Coal Mines for the North-east Coast area, where he gained useful experience in the application of electrical driving in various public and private undertakings, including collieries, steel works, &c. He is an M.I.E.E. and M.I.Mech.E.

Catalogues, Price Lists, &c.

An effective hanging card, which is well-printed in colours, has been issued by Messrs. Siemens Bros. & Company, Ltd., of Woolwich, relating to the Stannos system of wiring for electric light and power installations. The advantages of the system are clearly shown by the print and illustrations. The showcards, which are eyeletted and corded, will be supplied free of charge to merchants, contractors and traders on application.

Descriptive List No. 4,154-B of the British Thomson-Houston Company relates to ironclad oil-break switchgear of the non-draw-out type for mining and industrial purposes. The switchgear is designed for factories, collieries, mills and situations where enclosed apparatus is necessary and meets fully the Home Office Regulations for factories and mines. The List, which is copiously illustrated, gives particulars of design and construction, ratings, dimensions, &c.

The Automatic & Electric Furnaces, Ltd., 281-3, Gray's Inn-road, W.C. 1, have issued a new catalogue, which gives particulars of the design and construction of the Wild-Barfield Electric Resistance Furnaces. Among the advantages claimed for these furnaces are the certainty of the temperature and of the results, low cost of operation, rapid and uniform heating, and operative efficiency. The furnaces are constructed substantially of steel, and it is stated that all types give a very large output in proportion to the space occupied. Among other information in the catalogue are tables of the approximate sizes, outputs and current consumption of standard radiation and salt-bath furnaces, particulars of the W.B. case-hardening furnace, W.B. quenching baths, &c. The tendency is towards larger sizes of furnaces in order to meet the increasing demand for mass production and also the hardening of long articles such as cam-shafts, tools, gear wheels, gun barrels, &c.

Messrs. Van Raden & Company, Ltd., of Coventry, have issued a set of new lists which contain prices and particulars of the accumulators manufactured at their works. The business was purchased about 18 months ago by Mr. R. Rankin, M.I.E.E., and the factory has been reorganised and equipped to enable rapid delivery being given. The present lists are fairly representative of the company's products, but they do not include all the accumulators manufactured. The types listed include the B.A. celluloid accumulators for ignition and car lighting, the B.B. accumulators for car lighting, D.A. cells for American cars, and L.A. accumulators specially constructed for the tropics and for rough usage. In all cases the voltage capacity in ampere-hours, the charge and discharge rates and dimensions are given. In addition, there are some useful notes about the construction and design of the plates and a specification of the L.A. accumulators. The company, which has a department for repairs, will send copies of the lists to those interested.

Miscellaneous.

The death is announced of Ald. J. Coupe, who was for many years chairman of the Electricity Committee of Rawtenstall Corporation.

We regret to record the death of Mr. John Tudor Crowe, which took place on the 11th inst. after a short illness. Mr. Crowe was staff manager of the Eastern Telegraph Company, and had been all his life engaged in the telegraph service. He was 66 years of age.

Last week William Humphries, a turbine driver at Oldham Electricity Works accidentally touched one of the isolator switches and received a shock from current at 6,000 volts, but owing to prompt medical attention he recovered consciousness after an hour and a-half's artificial respiration. A few hours later Humphries had regained his full faculties.

Messrs. Vandervell & Company, Ltd., the manufacturers of the C.A.V. electrical productions have completed the addition of their new coil ignition system to the lighting and starting installation already fitted to H.M. 57-h.p. Daimler. The Company were recently the recipients of the Royal Warrant, their equipment being fitted to the whole of the Royal fleet of automobiles.

A mistake by a cable jointer, while repairing some cables at Newcastle-on-Tyne last week, led to the death of two men named Farrer and Kennedy. When the foreman got the list of cables completely repaired from Farrer power was turned on, but one blew out, the two men being killed. It was then found that the cable had only been partly jointed, while another, which was not on the list, was ready for use.

A Bill has been introduced into the House of Lords by Lord Balfour of Burleigh in order to Amend the Advertisements Regulation Act, 1907. It proposes to give local authorities power by by-law to regulate all advertisements on lands and buildings, and to prohibit advertisements which do not relate to the land or building on which they are intended to be exhibited, and also moving or flashlight advertisements.

On the 20th ult., Mr. D. R. O'Donovan, who secured all the Sidecar Class Records for the 100 miles, 150 miles, one, two and three hours, relied exclusively for his ignition on the C.A.V. all-British magneto, a splendid testimony to the reliability of Messrs. C. A. Vandervell's product. The new figures constitute records for not only his own class (500 c.c.), but for engines up to 1,000 c.c., a remarkable achievement considering the size of the Norton engine.

On the 28th ult. the directors of Siemens Brothers & Company, Ltd., presented to the Siemens Sports Club, which has been formed by the company's employees at Woolwich, a football challenge shield for competition between the various departments. The presentation was made by two of the directors, the Rt. Hon. Sir William Bull, M.P., and Mr. G. Chauvin (managing director), who also handed over a room for the Club until a suitable sports ground can be found. Sir William Bull congratulated the Club upon its success in having enrolled over 1,300 members. The first winner is the Apparatus Machine Shop, which thus heads the list of names to be engraved upon the shield. It was designed and made at the Woolwich works and is a handsome piece of work, possessing many unique and emblematic features. It is constructed in fine figured oak upon which, carved in bas-relief, are shown some of the company's products, viz., overhead telegraph and power lines, an automatic telephone instrument, a searchlight projector, primary cells, and also a representation of the company's c.s. "Faraday" and of a deep-sea grapnel. The shield is 6 ft. in height and is arranged for suspension by means of a suitable length of an actual cable which played no inconsiderable part in the successful defeat of the submarine menace.

Amongst the many fascinating exhibits at the recent Iron and Steel Institute Conversazione, one of the most interesting was the B.T.-H. Thermostatic Metal particulars of this metal, which is intended for temperature indication or for the thermostatic operation of devices depending on heat control, were given in The Electrician of Feb. 13 last. For the exhibit three rough models were made up. Model "A" was a device for taking the temperature of liquids and consisted of two strips of the metal riveted together at the lower end. Model "B" was an oven thermometer, the strip lifting a curved arm attached to the spindle of the pointer. The scale was only for comparative measurement, the 25 and 45 marks representing the respective boiling points of water and oil. In Model "C" the temperature indication is absolutely direct, the thermostatic strip being fixed horizontally in front of a graduated card. Of course, these three models do not exhaust the possibilities of the metal, and any engineer or instrument maker can think of countless ways in which it could be usefully employed. In many cases it will be found a more convenient means of temperature indication than an ordinary thermometer. It may also be employed for automatic cut-outs, for switching electric current on and off, relays for releasing sun-blinds, for turning gas up and down, &c. Further information may be obtained from the British Thomson-Houston Company, Ltd., 77, Upper Thames-street, London, E.C. 4.

Bankruptcies and Liquidations.

Edw. S. Elam and John Waldon, electricians, 63, King Edward-street, Hull, have been adjudicated bankrupt. The first meeting of creditors will take place on June 25, at York City Bank-chambers, Lanegate, Hull, and the public examination on July 5, at the Guildhall, Alfred Golder-street, Hull.

Final meetings of the members of Fuller's Wire & Cable Company, Ltd. Fuller's Carbon & Electrical Company, Ltd., the Fuller Accumulator Company, Ltd., and John C. Fuller & Son, Ltd. (in liquidation), will be held at the offices of Messrs. J. Dix Lewis, Cæser & Company, Kennan's House, Crown-court, Cheapside, London, E.C., on July 7. Fuller's United Electric Works, Ltd., has taken over and is carrying on the undertakings of all the above-mentioned companies.

Tenders Invited and Accepted.

Carlisle Corporation require tenders by June 25 for 3,000 kw. turbo-alternator and condensing plant. Specifications from City Electrical Engineer.

Salford Corporation require tenders by June 21 for high pressure steel steam pipes and separator and for steel exhaust steam pipes, &c. Specifications from Borough Electrical Engineer.

Swindon Corporation require tenders by June 26 for 3-in. 4-way stoneware conduits and light steel plates. Forms of tender, &c., from the Engineer, Electricity Works, Swindon.

Wood Green Council require tenders by noon July 13 for electric wiring and fitting in the Town Hall and Bound's Green-road Schools. Specifications, &c., from the Clerk of the Council.

The Irvinestown Trustees want tenders by June 25 for the installation of an electric lighting system for the town. Particulars from Mr J. J. Woods, Lisoggeston-terrace, Clones, Co. Monaghan.

Middlesbrough Corporation require tenders by first post July 6 for three or six months' supply of electric lamps, rubber goods, oils, paints, &c. Specifications, &c., from the Borough Engineer.

Nuneaton Corporation require tenders by 9 a.m., June 30, for 1,000 kw. d.c. geared turbo-generator surface condensing plant and pipework. Specifications from the Borough Electrical Engineer.

Dartford Urban Council want tenders for supply and erection of a rotary converter, transformer, switchgear, l.-t. twin cable feeder, &c. Specifications from and tenders to the Clerk to the Council by June 26.

Tenders are invited for the equipment and running of electricity supply works at Cape Coast and tramways at Coomassie (Gold Coast). Further information from the Secretary for Works, Accra. Tenders to the Colonial Secretary, Victoriaborg, Accra, by Sept. 1.

The date for the receipt of tenders by the New Zealand Public Works Department for synchronous condensers, service transformers and three-unit motor generator in connection with the Lake Coleridge hydro-electric undertaking is extended from June 30 to July 30.

Bedford Corporation electricity department invite tenders for the supply and erection of one 2-ton locomotive jib crane, grab and track rails, and steam and other pipework. Specifications from the borough electrical engineer, Mr. R. W. L. Phillips, to whom tenders by June 21.

Newport (Mon.) Corporation invite tenders for turbo-alternator and surface condensing plant, boiler, economisers, draught plant, &c. Specifications from the borough electrical engineer and tramways manager, Mr. A. Nichols Moore, and tenders to the Town Clerk, by June 26.

Tottenham District Council require tenders for supply and erection of electric motor charging plant, &c. Particulars from Capt. H. F. Wilkinson, R.E., engineer of the Council, Town Hall, Tottenham, N. 15. Tenders to the clerk and solicitor (Mr. Reg. C. Graves) by noon, July 1.

Glasgow Corporation invite tenders for supply and erection of a 10,000 kw. steam turbo-alternator, with condensing plant, for the tramways department. Specifications from the general manager, Mr. James Dalrymple, and tenders to the Town Clerk, Mr. J. Lindsay, by July 6.

Tenders are invited (by July 14) for the supply to the Postmaster General's Department, State of Western Australia, of telegraph and telephone instruments, &c., as per schedule 674. Tender forms from the High Commissioner, Room 406, Australia House, Strand, London, W.C.2.

The Tramways and Electricity Committee of Halifax Corporation invite tenders for the supply and delivery of two natural draught chimney-type water-cooling towers. Specifications from the borough electrical engineer (Mr. W. M. Rogerson) and tenders to the town clerk (Mr. Percy Saunders) by noon, July 8.

Manchester Electricity Committee want tenders by 10 a.m. June 25 for electricity meters (specification 21), time switches (22), potential and current transformers (23), motor starting switches (24) and continuous- and alternating-current motors (25). Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Dundee Corporation invite tenders for steam-feed and water piping and two turbine driven feed pumps. Specifications from the General Manager and Engineer, and tenders to the Town Clerk by June 24.

Dundee Corporation also require tenders by June 23 for wiring the new City Hall. Specifications from the City Architect, 91, Commercial-street, Dundee.

The New South Wales Government Railways & Tramways Department require tenders by August 4 for two 1,000 kw. rotary converters, six 365 kw. s. phase transformers and two blower sets; or (alternatively) two 1,000 kw. rotary converters and two three-phase oil-insulated self-cooled transformers. Specifications from the Chief Electrical Engineer for Railways.

Tenders are required (by Aug. 3) for the supply and erection at Perth (W.A.) of 326 accumulators (in accordance with Schedule W.A. 668), and also (by Aug. 2 and 5 respectively) for (A) aluminium sheet, brass rod, &c. (schedule 769) and (B) platinum wire, gold and silver wire, &c. (schedule 768), for the Australian Commonwealth, Postmaster-General's Department, New South Wales. Forms, &c., from the High Commissioner, Australia House, Strand, London, W.C. 2.

Clacton Urban Council has accepted the tender of the English Electric Company for a Diesel engine and generator.

Ormskirk Guardians have accepted the tender of Browett, Lindley & Company for a 40-kw. 220-volt steam-driven generating set, at £940.

Dartford Urban Council has accepted the following tenders: John Thompson, Water Tube Boilers, Ltd., boiler, £5,641; Johnson & Philli duplicate bus-bars, £765.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1919 Specifications.

141,4[illegible] Binks & Fe[illegible]. E[illegible]. (18 [illegible].)
141,453 Crick. [illegible]
141,488 Raw[illegible]. R[illegible] control of electrically-propelled vehicles or trains. (23 [illegible] 19.)
141,550 Western Electric Co. & Deakin. Mixed manual and machine-switching telephone exchange systems and the designation of subscribers' lines therein. (6 6 19.)
141,554 Olivetti. Magneto-electric machines. (11 6 19.)
141,555 Olivetti. Magneto-electric machines. (11 6 19.)
141,559 Gush. Means for mounting electrodes employed in the prevention of corrosion in steam-boilers, condensers and the like. (18 6 19.)
141,577 Marks. (Spardon Electrical Products Co.) Electrical fire-alarm systems. (9 7 19.)
141,584 Dale. Apparatus for converting direct electric current into high-frequency alternating current. (18 7 19.)
141,587 Chandler. Wireless direction finding apparatus. (25 7 19.)

Consists in combining with a direction finding apparatus a corrector coil or coils, or loop in which the waves produce a current which can be adjusted to neutralise the voltage produced in the direction finding aerials owing to the mutual induction between the latter and the metal work of the aircraft or the like, the coil or coils preferably being connected through a switch which is rotated as the direction finding apparatus is rotated, through a wave change switch and through variable resistances and or condensers, and/or inductances.

141,604 Roberts & Matson. Sending-keys for electric telegraphs. (19 2 19.) (Divided Application, on 139,259.)
141,633 O'Neil. Electrical indicating devices. (24 7 18.) (Divided Application on 141,388.)
141,634 O'Neil. Electrical indicating devices. (24 7 18.) (Divided Application on 141,388.)

1920 Specifications.

141,305 Hepburn. Electrolysers. (22 2 19.) (Divided application on 139,296.)
141,310 Sterling Telephone & Electric Co. & Davey. Automatic telephone exchange system. (31 12 18.) (Divided application on 141,106.)
141,311 Sterling Telephone & Electric Co. & Davey. Automatic telephone exchange system. (31 12 18.) (Divided application on 141,106.)
141,312 Sterling Telephone & Electric Co. & Davey. Automatic telephone exchange system. (31 12 18.) (Divided application on 141,106.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

January 16, 1920.

1,500 Akt. Ges. R. Bosch. Devices for preventing starting of electrically ignited engines. (27 3 16. Germany.)
1,507 American Bosch Magneto Corpn. Housings for mechanical interruptors of electric ignition apparatus. (7 2 19. U.S.)

January 17, 1920.

1,529 Hodges. Commutators.
1,541 Dean-Osgood. Electric heating element.
1,551 Beavan & Hopper. Induction incandescent lamps.
1,552 Beavan & Hopper. Metal filament vacuum and gas-filled incandescent lamps.
1,566 Hodges. Fusible cut-outs and distribution fuse boards.
1,570 Boucherot. Armoured cables. (1 5 14. France.)
1,583 Hunt. Insulation of conductors of submarine cables.
1,587 Ferranti & Wall. Electricity meters &c.
1,591 B.T.-H. Co., Durrant & Young. Electrical condensers.
1,610 Grafton. Electrical brush gear.

January 19, 1920.

1,612 Dean-Osgood. Electric fire.
1,627 Conner & Puckette. Circuits of ignition systems.
1,635 Baden-Powell. Visual telegraphy.
1,645 Hearn. Electrically-heated apparatus.
1,650 Merryweather & Osborne. Electrically-operated pumps.
1,659 B.T.-H. Co. (G.E. Co.) Electric devices.
1,670 Wilson. (Buckley.) Commutators.
1,687 Akt.-Ges. R. Bosch. Ignition apparatus. (15 3 19, Germany.)
1,694 George. Tramcar trollies.

January 20, 1920.

1,750 Readett. Electric welding, brazing, &c., machines.
1,763 Reyrolle. (Van Steveren.) Protective arrangements for electrical distribution systems.
1,768 Hansen. Electrically propelled vehicle.
1,810 B.T.-H. Co. (G.E. Co.) Rotary electric transforming apparatus.
1,821 Moser. Electric switches. (19 4 19, France.)
1,840 Cie Francaise des Metaux. Electric induction furnaces. (7 2 19, France.)
1,843 Akt.-Ges. R. Bosch. Battery ignition. (25 11 18, Germany.)
1,844 Akt.-Ges. R. Bosch. Electric lighting of automobiles.

January 21, 1920.

1,871 Eccles & Vincent. Wireless telegraphy and telephony.
1,873 Tucker. Electric switches.
1,880 Meyer. Electric heater and disinfector for beds.
1,887 Fraser. Electric burglar alarm.
1,893 Dallisai. Electric hand lamps.
1,959 Harris. Electricity motor meters.
1,966 Moser. Electric switches.
1,973 Akt.-Ges. Brown, Boverie et Cie. Controllers for high-voltage direct-current railways. (21 1 19, Switzerland.)
1,978 Akt.-Ges. R. Bosch. Projector for glow lamps. (11 5 19, Germany.)
1,981 Ashcroft. Electrolytic production of magnesium from anhydrous magnesium chloride.
2,005 Rees. Wireless telegraphy receivers.

January 22, 1920.

2,031 Bolton. Apparatus for grinding electric accumulators or distributors.
2,054 Hollingworth. Electromagnetic wave signalling.
2,069 Lignori. Transformers.
2,084 B.T.-H. Co. (G.E. Co.) Electromagnetic switches.

January 23, 1920.

2,130 Davis & Digger. Clips for holding electric conduits.
2,133 Automatic Telephone Mfg. Co. & Savin. Automatic telephone systems.
2,151 Tweedale. Electrical machinery.
2,175 Thomas Transmission, Ltd. Ignition for engines.
2,186 Siemens Bros. Dynamo Works & Parker. Dynamo-electric machines.
2,338 Airey, Bryan, Fortescue & Macrory. Valves or tubes for wireless telegraphy, &c.

January 24, 1920.

2,236 Kitchin. Electrical resistances, potentiometers, &c.
2,237 Chatten. Transmitters for electric signalling systems.
2,296 Simpson. Cooling systems for turbo-generators.
2,302 Lucas & Urquhart. Automatic switches for dynamos.
2,303 British Arc Welding Co. & Ogden. Electrodes for electric arc welding.
2,304 Marks. (Oesterreichische Siemens-Schuckert Werke.) Electrical transference of designs in textile arts.
2,327 Petter. Apparatus for electric heating of hot bulb engines.

Companies' Reports, &c.

The directors of O. C. Hawkes, Ltd., have declared an interim dividend on the ordinary shares at the rate of 6 per cent. per annum for the half-year ending to June 30.

The Globe Telegraph & Trust Co., Ltd., has declared a final dividend for year ended May 31 of 14s. per share, tax free, making 10 per cent. for the year, compared with 5 per cent. in the previous year.

In connection with the new issue of £160,000 in £1 ordinary shares by Messrs. A. Reyrolle & Company, Ltd., our readers are reminded that the lists will be closed on Saturday, June 19, but applications received by post on Monday, the 21st inst., will receive consideration.

The report of Mirrlees, Bickerton & Day, Ltd., for the year ended March 31, 1920, states that the net profit, after providing for depreciation, excess profits duty, &c., is £41,812. The directors recommend a dividend on the ordinary shares, making 12½ per cent. (tax free) for the year; £5,000 is to be placed to reserve, leaving £7,510 to be carried forward.

The revenue of the Lewes & District Electric Supply Company, Ltd., for 1919 was £5,013 and working expenses were £3,856, leaving £1,156. After providing £440 for debenture interest and writing off £248 in respect of obsolete material and adding interest (£101) and £868 brought forward, the available balance is £1,437, of which £600 has been placed to renewal fund and £837 carried forward.

The directors of the Great Northern Telegraph Company, Ltd. (of Denmark), propose for the year 1919 the distribution of a total dividend and bonus of 22 per cent., including 5 per cent. already paid, and to transfer £61,111 to reserve and renewal fund, and £55,556 to renewal fund for cable steamers. A sum of £41,667 has been allotted to the pension fund, and is it also proposed to set aside £305,556 for extraordinary taxes, and to carry forward £141,606.

At the recent meeting of the Trowbridge Electric Supply Company, Ltd., it was reported that the past year's profit was £522, and with the amount brought forward the available total was £562. Dividends of 5 per cent. on the ordinary and preference shares were declared, a sum of £275 was transferred to depreciation, and £122 carried forward. The chairman (Mr. Blake) said the company was in a transition stage. The electric supply had been a great boon to the town, and the amount of current used was proof that the undertaking was needed. They were much indebted to Messrs. Edwards and Armstrong for the economical way they ran the works and for making such a great success of the undertaking. It was decided to increase the capital from £4,000 to £6,000 by the issue of 2,000 ordinary shares of £1 each.

The receipts of the Delhi Electric Tramways & Lighting Company, Ltd., for 1919 were £47,591 (£15,093 from tramways and £32,498 from electric supply). The net revenue is £20,430, compared with £18,010 in 1918. The profit (including that on exchange) was £14,081, after charging general expenditure in London and Delhi, debenture interest, depreciation, providing a reserve of £500 for taxation in India and adding £2,500 to reserve for renewals. It is proposed to write £5,000 off balance of preliminary expenses, to pay 7 per cent. per annum upon the preferred and participating shares (requiring £7,000) and 1s. 4½d. per share upon the ordinary shares, leaving £87. With amount brought forward the balance to be carried forward is £1,362. Additions to plant made during the year amount to £3,073. Further plant, equipment and mains required to meet the growing demands have been ordered, and the question of providing for future developments is receiving consideration.

The total receipts of the Greenock & Port Glasgow Tramways Company for 1919 were £73,364, and after meeting expenses, including £2,146 for mortgage interest, amounts payable under agreements with Corporations (£1,473), and setting aside £6,000 for renewals, the surplus is £7,319, making, with £4,876 brought forward, and £2,500 transferred from reserve, a total of £14,694. The directors have placed £1,778 to sinking fund for loan redemption, and after paying the 5 per cent. preference dividend, it is proposed to pay 16s. per share on the ordinary shares (£9,200) and to carry forward £217. The continued rise in wages and in the cost of materials has rendered an increase of fares an urgent necessity. The Greenock Corporation have been applied to for a modification of the fares specified in the lease of 1902; but, notwithstanding that costs have more than doubled since the pre-war period, and that fares have remained the same, the Corporation declined to agree to any upward revision. The directors therefore propose to take proceedings under the Courts (Emergency Powers) Acts in order to obtain a revision of the terms of the lease.

The net profit of Marconi's Wireless Telegraph Company, Ltd., for 1919 was £1,220,739 (including £590,000 from the Government as damages for breach of contract), compared with £597,938 in 1918. With £463,787 brought forward the total is £1,684,526. A dividend of 25 per cent. has been declared on the old ordinary shares and 22 per cent. on the preference shares, and it is also proposed to pay a bonus of 5s. per share on the ordinary and preference shares, and to carry forward £955,202 (against £463,787). No settlement has been made with any of the Government Departments in respect of the company's claims arising out of the war or for services rendered during the war. In consequence of unfavourable rates of exchange which obtained at the end of the year, considerable sums of money have been allowed to remain abroad on deposit or invested in Foreign Government securities. A sum approximating £58,000 has been debited to profit and loss account, calculating the rate of exchange on Dec. 31, as though the money had been brought home at that date, and the loss incurred. A sum of £56,000 has also been written off, representing depreciation in investments in British and Foreign Government securities. Lord Haldane has been appointed a director of the company.

The revenue of the Cork Electric Tramways & Lighting Company, Ltd., for the year 1919 was £90,861, and expenses were £70,734. Adding balance from 1918, the amount available is £19,176. A sum of £6,500 has been added to reserve for depreciation and renewals, and £4,000 to maintenance reserve, and after payment of the dividend on the 5 per cent. cumulative preference shares it is proposed to carry the balance (£2,512) forward. The revenue showed an increase of £11,941 over 1918 (tramways £4,930, lighting and power £6,232, and other revenues £779), but the expenses increased by £13,349. Of the increased expenditure £5,181 was for maintaining and operating the tramways, £5,589 for generating, £869 for lighting and power maintenance, and £1,710 for general and administrative charges. The Board of Trade sanctioned in August last an increase in tramway fares, and the revenue has since materially improved. With regard to lighting and power, although business continues to extend, the increased revenue is mainly due to the additional charges imposed to meet the continuous increases in generating and maintenance expenses. Further adjustments of charges are under consideration to meet increased cost of coal and wages. The capital expenditure (£13,290) has been mainly for house services, cables and additional plant for the power station. It has been necessary to instal additional plant to meet the demand for new lighting and power connections, and these extensions (including a 2,000 kw. Curtis turbine) are in course of construction. The lease of the Lighting Order from Cork Corporation, which expired in August, 1918, has been renewed for 40 years, subject to the approval of the Board of Trade.

The report of the Lancashire Power Construction Company, Ltd., states that, as a result of the Parliamentary Company's operations for the year 1 19, that company has, after payment of debenture interest and placing of £15,000 to reserve, declared a dividend of 7 per cent. upon its issued share capital, all of which is held by the Construction Company. This will produce £35,660, and with interest, &c., the total receipts for the year amount to £41,477. Deducting debenture interest, trustees' fees and general expenses (£17,219) and adding £8,441 brought forward, the available balance is £32,699. The directors recommend payment of dividends at rate of 6 per cent. per annum on the cumulative convertible first preference shares, at rate of 7 per cent. per annum on the seven per cent. cumulative participating preference shares, and at rate of 6 per cent. per annum on the paid ordinary shares, leaving £9,648 to carry forward. Owing to the change from war to peace conditions, and especially to the reduction in working hours in practically all industries, the Parliamentary Company's output has not quite maintained the normal rate of expansion, but in spite of the difficulties the trading result has improved, and the Parliamentary Company has been able to increase its dividend from 6 to 7 per cent. New contracts entered into during the year will have the effect of approximately doubling the Company's output as soon as the plant on order is in commission. In addition enquiries have been received considerably in excess of the Company's capacity to supply even when the present extensions are completed. The continued high price of coal seems to have brought home to power users in every industry the great advantages of central electric power supply. The extensions at the power station are making good progress, and it is hoped that the first of the two 10,000 kw. sets on order will be operating in October, and the second about four months later.

Sir Frederick Green, K.B.E., presided over the meeting of the United River Plate Telephone Company, Ltd., and after an analysis of the report and accounts (abstracted in our last issue), he stated that owing to the shortage of switchboard capacity they had unfortunately not been able to give a service to all who required it, notwithstanding the bringing into use of a new common battery exchange in Buenos Ayres last July. By adopting certain methods permissible only in times of difficulty they had been able to supply telephones to 6,166 new subscribers, making the total number of stations 78,171 against 72,005 at the end of 1918. At present there were over 5,000 on the waiting list in Buenos Ayres, which it would be impossible to reduce to any extent until the additional switchboards (some of which were in the course of erection) were completed. The new switchboards, with one exception, were merely additions to existing exchanges. To provide the further telephone facilities which are urgently needed it has been necessary to prepare schemes for new exchanges in other parts of the capital. Until recently there were difficulties in connection with the introduction of an automatic system into a city where telephone service was already being given by manually operated exchanges, but those difficulties had now been overcome, and so, after careful consideration, they came to the conclusion to adopt the automatic system for Buenos Ayres, and they had therefore ordered one of the Strowger type, similar to that in use at Cordoba and Rosario for some years. It was being manufactured in England, and should no unforeseen delay take place it was hoped delivery was made during the early part of next year. The Government regulations, which had hindered the company's progress and expansion, had been modified, but the difficulty of obtaining supplies would now cause delay. Their new exchanges, together with the continued expansion of the business, would mean a considerable expenditure, and it would be necessary to provide further capital. It was therefore resolved to increase the capital of the company from £2,000,000 to £2,500,000 by the creation of 100,000 new shares of £5 each.

Mr. James Gray, who presided over the annual meeting of the Electric Construction Company, Ltd., on the 10th inst., stated that the gross profit for the past year was £400 more than in 1918-19, but the net profit was £2,511 less, due to an increase in general charges (income tax, rates, insurance, &c.). The usual interim dividends of 7 per cent. per annum on the preference and 6 per cent. on the ordinary shares were paid and they were now paying final dividends of 7 per cent. on the preference and 9 per cent. per annum on the ordinary shares (making 7½ per cent. for the year), and also a bonus of 2½ per cent. on the ordinary shares. The transfer to general reserve was £10,662 12s., leaving to be carried forward £39,781. The company's lease of the premises at Millwall, which were occupied by the Electrical Power Storage Company, had been sold. They had expended on additions to plant and buildings £44,883. The extension consisted of three bays measuring 330 ft. by 110 ft. and the whole of their switchgear department had been transferred to the new shops, a greatly increased output being now possible.

Having given an analysis of the report and accounts, Mr. Gray drew attention to the fact that £20,000 had been paid on account of excess profits duty to March 31, 1919, leaving the balance for that year and the full assessment for the year ended March 31, 1920, to be deducted from the balance carried forward of £39,781 7s. 4d. The proposed corporation profits tax, if confirmed, would also fall to be deducted from the carry forward, but the amount available was more than sufficient for those requirements. When war broke out the manufacturing electrical industry was emerging from a long period of depression, caused largely by strenuous and unfair foreign competition, and the excess profits duty had, therefore, weighed heavily upon the industry in consequence of low pre-war standards. In the case of their company the sums paid in excess profits duty and munition levies since their inception had exceeded the dividends to the ordinary shareholders after deducting income-tax. It would be difficult to find words more forcible than those used by the Chancellor of the Exchequer last year in favour of the abolition of excess profits duty, but, to the surprise of the community, he had not only decided to continue the duty, but to increase it from 40 to 60 per cent. as from Jan. 1 last. Every reasonable person acknowledged that the money had to be found, and was ready to pay his share, but what he objected to was an unfair distribution of the burden. Excess profits duty was imposed in a time of stress and it served its purpose, but to continue it was a direct encouragement to extravagance, and, in his opinion, it would not conduce to increased production, which was vital to the rehabilitation of the country's finances. The labour outlook was still very uncertain, although the relations with their own men were quite satisfactory, and, provided there was no dislocation by strikes or otherwise, they looked forward with complete confidence to the results of the new year.

New Companies.

ANGLO-RUSSIAN ENGINEERING COMPANY (BIRMINGHAM), LTD. (167,458)—Private company; reg. May 14, capital £1,000 in 5s. shares, to carry on the business of electricians, mechanical engineers, manufacturers of and dealers in electrical apparatus, &c. Secretary, J. Hastings. Reg. office, 20, Guildhall-buildings, Stephenson-street, Birmingham.

W. CANNING & COMPANY, LTD. (167,927.)—Public company; reg. June 1, capital £450,000 in £1 shares. The objects are: To carry on the business of manufacturers of and dealers in polishing and plating plant, machinery, apparatus, and materials for electro platers, polishers and electro-depositors, electrical and general engineers, &c., and to adopt an agreement with E. R. Canning. First directors are E. R., T. R. and A. B. Canning, E. Williams, and G. A. Pope. Reg. office, 137, Great Hampton-street, Birmingham.

CATCHPOLE & MAURICE, LTD. (167,513).—Private company. Reg. May 17, capital £5,000 in £1 shares, to take over the business of wholesale and export electrical and mechanical engineers and merchants formerly carried on by A. E. Catchpole and E. Maurice. First directors are: A. E. Catchpole, C. B. Maurice, F. W. Dennis and W. N. Scovell. Reg. office: Albion House, 59-61, New Oxford-street, W.

DURELCO, LTD. (167,994).—Reg. June 4, capital £300,000 in £1 shares, to acquire all or the majority of the shares in, and the undertakings of Duram, Ltd., Cryselco, Ltd., and Metal Manufacturers, Ltd., and to carry on the business of manufacturers of drawn wire and electric lamps, and all articles made of molybdenum and other metal, &c. First directors are: W. L. T. Arkwright, J.P., the Earl of Kintore, P. H. G. Powell-Cotton, Capt. E. G. S. Churchill, D.L., J.P., G. G. Craig, W. W. Worthington, J.P., and J. C. Moulden. Reg. office: Thanet House, 231-2, Strand, W.C.

GALPIN, HALL & COMPANY, LTD. (168,026).—Private company. Reg. June 4, capital £6,000 in £1 shares, to take over the business of a gas, electric and general engineer, carried on by S. B. Galpin at Scunthorpe and Frodingham. Permanent directors: S. B. Galpin (manager), J. M. Hall (managing director and secretary) and G. Foster. Reg. office: 200, High-street, Scunthorpe, and Frodingham, Lincs.

GARRETT, GREEN & COMPANY, LTD. (166,907.)—Private company; reg. April 29, capital £4,000 in £1 shares, to take over the business of electrical and mechanical engineers carried on by G. W. Green and R. L. Calder as "Garrett, Green & Company." First directors are G. W. Green, R. L. Calder, G. W. Green, sen., and W. J. Calder. Reg. office, 139, Derby-street, Burton-on-Trent.

GOODALL ELECTRIC, LTD. (167,261)—Private company. Reg. May 8, capital £2,000 in £1 shares, to take over the business of electricians carried on by T. J. Stapley, W. J. Mills and T. C. Jones at Liverpool as the Standard Electric Company. First directors are L. Jackson and T. R. M. Chetter. Reg. office: 64, County-road, Walton, Liverpool.

HAYS, STANDEN & COMPANY, LTD. (167,869.)—Reg. May 31, capital £50,000 in £1 shares, to take over the business of engineers, merchants and manufacturers carried on as Hays, Hunter & Standen, Ltd., and to carry on same and the business of dealers in machinery and plant, castings for electrical, motor and allied industries, switches, lampholders, &c. First directors are J. D. Garrett, P. J. Hays and H. W. Standen. Reg. office, 71, Southwark-street, S.E.

VICKERS BRITISH EAST AFRICA, LTD. (168,013).—Private company. Reg. June 4, capital £8,000 in £1 shares, to carry on the business of manufacturers of and dealers in steel, iron, brass and metals, shipbuilders, ordnance manufacturers, electricians, &c. First directors are Sir Francis Barker, S. A. Dardier and N. Robinson. Reg. office: Vickers House, Broadway, Westminster, S.W. 1.

Forty Years Ago.

(The Electrician, June 19, 1880.)

Scottish Telephonic Exchange.—The number of subscribers is increasing, and the number of conversations by telephone passed through this exchange exceeds 2,000 per week, which makes the average about 30 per subscriber, there being about 90 subscribers, of whom 20 or more were at the time of information not yet joined up.

Society of Arts.—The Council of the Society of Arts attended on Monday last, at Marlborough House, when the Prince of Wales, as President of the Society, presented to Sir William Thomson, F.R.S., D.C.L., LL.D., the Society's Albert Medal, awarded to him in 1879, "on account of the signal services rendered to arts, manufactures and commerce by his electrical researches, especially with reference to the transmission of telegraphic messages over ocean cables"; and to James Prescott Joule, F.R.S., LL.D., D.C.L., the Albert Medal for the present year, awarded to him "for having established, after more laborious research, the true relation between heat, electricity, and mechanical work; thus affording to the engineer a sure guide in the application of science to industrial pursuits."

Telegraphic Progress.—The telegraphic service, says "Engineering," between the United States and Europe is in a satisfactory condition, but there is no good communication by wire between North and South America, or between the United States and Asia. Europe, on the other hand, has been wonderfully active in the extension of lines and cables to other Continents. There are now two cables between France and Algiers; Cairo and Khartoum have been connected; a wire has been carried to Cabul; the Transvaal has been connected with Cape Town; and the latter place is now in connection with Europe, *via* Natal, Delagoa, Mozambique, Zanzibar and Egypt. Another line has been established between Asterabad and Tiflis, through the whole of Persia, while Russia is extending its telegraphic network to Eastern Siberia. Much progress has been made in the domestic telegraphic system of Brazil, especially in the interior; a cable has been laid along a good part of the western coast of South America; and all the settled portions of Australia and New Zealand are now in active communication with one another as well as with Europe. A new cable connects Port Darwin, the northern terminus of the trans-continental line of Australia, with Java, Singapore, Malacca and Penang. Several cables have been laid in the Baltic. The cables now required are one across the Pacific, two between the United States and Rio and Valparaiso respectively, as well as minor cables to connect Cayenne, Colombia, New Caledonia, the Phillipine Islands and Chinese stations with the world's telegraphic system.

Prices of Metals, Chemicals, &c.

Tuesday, June 15.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£105 0 0	—	£2 0 0
Electro Wirebars...	..	£108 0 0	—	£2 0 0
H.C. wire basis......	per lb.	1s. 3 1/16d.	—	3/16d.
Sheet	,,	1s. 5¼d.	—	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 8 1/16d.	—	3/16d.
Brass 60/40—				
Rod, basis	,,	0s. 10¾d.	—	¼d.
Sheet, basis	,,	1s. 3¾d.	—	—
Wire, basis	,,	1s. 3¾d.	—	—
Iron—				
Cleveland Warrants	per ton	£11 17 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£51 0 0	—	—
Lead Pig—				
English	,,	£38 10 0	£0 10 0	—
Foreign or colonial	,,	35 10 0	—	—
Tin—Ingot	,,	246 5 0	—	£7 15 0
Wire, basis	per lb.	0 3 3	—	1d.

Salammoniac.—Per cwt. 105s.-160s.

Sulphur (Flowers).—Per ton £19.

,, (Roll Brimstone).—Per ton £19.

Sulphuric Acid (Pyrites, 168°).—Per ton, £8 8s. 9d.

Copper Sulphate.—Per ton £44

Boric Acid (Crystals)—Per ton £74.

Carbon Bisulphide.—Per ton £60

Sodium Bichromate.—Per lb. 1s. 11d.

Sodium Chlorate—Per lb. 5½d

Rubber.—Para fine, 2s. 1d.; plantation 1st. latex, 2s. 0¼d. per lb.

Shellac.—T.N. Orange, 620s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Company, Ltd.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics":—Our Dinner to the Pioneers of Aviation of the Royal Air Force; and "A New Theory of Air Screws," by A. R. Lane.

"Cabinet Maker":—"Practical Polishing Methods of Filling Grain"; "Three Legged Tables"; and "Coir or Coco Fibre as an Upholstering Material."

"Chemical Age":—"Industrial Applications of Liquid Air and Oxygen (I.-II.)"; and "Chemical Liquor Pumping."

"Fruit Grower":—"State Recognition of Commercial Horticulture"; "A Bucks Nursery and Fruit Farm"; and "Fruit Crop Prospects."

"Gas World":—"Labour," by Sir Arthur Duckham; "Gas and Electricity as Sources of Heat, Light and Power," by Sir Dugald Clerk; and "Electricity Supply of Gas Companies," by W. A. Tookey.

"Hardware Trade Journal":—"Ventilation in Factories and Workshops"; "The Fire Arms Bill"; and "Milling Cutter Arbors."

"Ways and Means":—"The New Outlook in Industry," by W. Peter Rylands; "The Extravagance of Governments," by Sir George Paish; and "Wool Profits and Fictions," by Frank Fox.

Arrangements for the Week.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Monday, June 21st.

8 p.m. At the Winter Gardens, Ilkley. Informal reception.

Tuesday, June 22nd.

10 a.m. At Queen's Hall, "The Windsor," Morley-street, Bradford. Opening of the Convention. Welcome by the Rt. Hon. the Lord Mayor of Bradford, Ald. W. Wade, J.P. Presidential address by Mr. T. Roles and Paper on "The Design of Distributing Networks," by Mr. A. C. Gillin.

1 p.m. Luncheon to Members, Delegates and Visitors, by the Bradford Electricity Committee.

2.15 p.m. Visit to the Phœnix Works of the English Electric Company.

1.15 p.m. Visit to Bradford Corporation Electricity Works.

8 p.m. Reception at the Winter Gardens, Ilkley, by the Chairman of the Ilkley Urban District Council, followed by Social Evening.

Wednesday, June 23rd.

10 a.m. In the King's Hall, Winter Gardens, Ilkley. Paper on "Power Station Design in Relation to Thermal Efficiency," by Mr. I. V. Robinson.

Excursion to Bolton Abbey.

7.15 p.m. Annual Dinner in the King's Hall.

Thursday, June 24th.

10 a.m. In the Queen's Hall, "The Windsor," Morley-street, Bradford. Paper on "The Standardisation of Tariffs," by Mr. J. W. Beauchamp.

1 p.m. Luncheon to Members, Delegates and Visitors, by the Bradford Electricity Committee.

2.15 p.m. Visit to the Mills of Messrs. Sir Titus Salt, Bart., Sons & Company, at Saltaire.

4.30 p.m. Reception at the Cartwright Hall, Lister Park, by the Rt. Hon. the Lord Mayor of Bradford, Ald. W. Wade, J.P.

8.30 p.m. In the King's Hall, Ilkley. Meeting restricted to Committee Members of the Association.

Friday, June 25th.

9.15 a.m. In the Winter Garden, Ilkley. Meeting of the Council.

10 a.m. In the King's Hall, Ilkley. Annual General Meeting.

1.45 p.m. Trip to Pateley Bridge and the Nidd Valley.

WEDNESDAY, June 23rd.

Institution of Electrical Engineers.—Wireless Sectional Meeting.

6 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Paper on "The Development of Thermionic Valves for Naval Uses," by Mr. B. S. Gossling.

FRIDAY, June 25th.

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read: "The Origin of the Elements," by Dr. J. H. Vincent, M.A.; "The Construction of Thermo-Couples by Electro-Deposition," by Mr. W. H. Wilson and Miss T. D. Epps, "On the Use of Vacuum Arcs for Interferometry," by Mr. J. Guild; and "The Maintenance of a Vibrating System by Means of a Triode Valve," by Mr. S. Butterworth, M.Sc.

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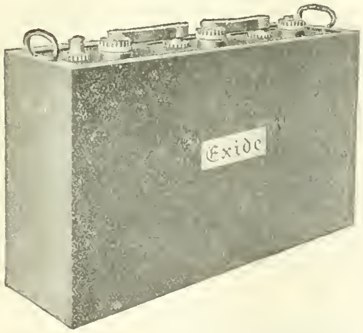

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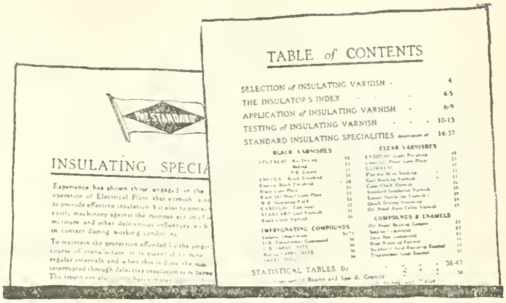

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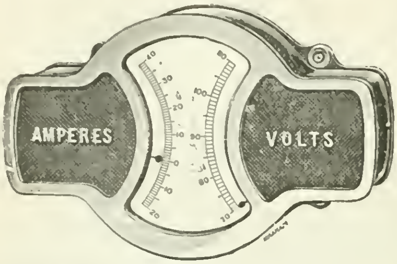

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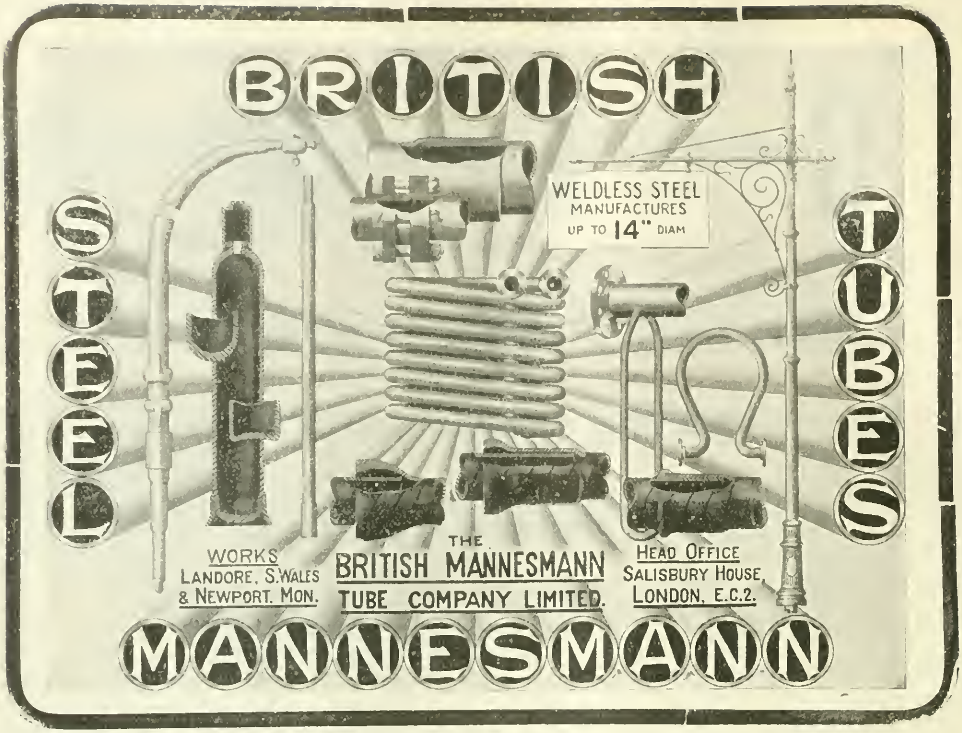

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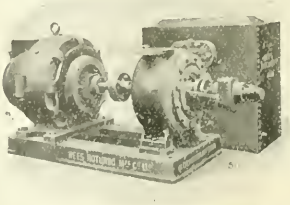

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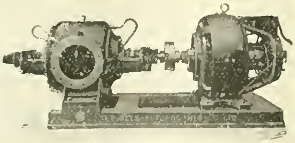

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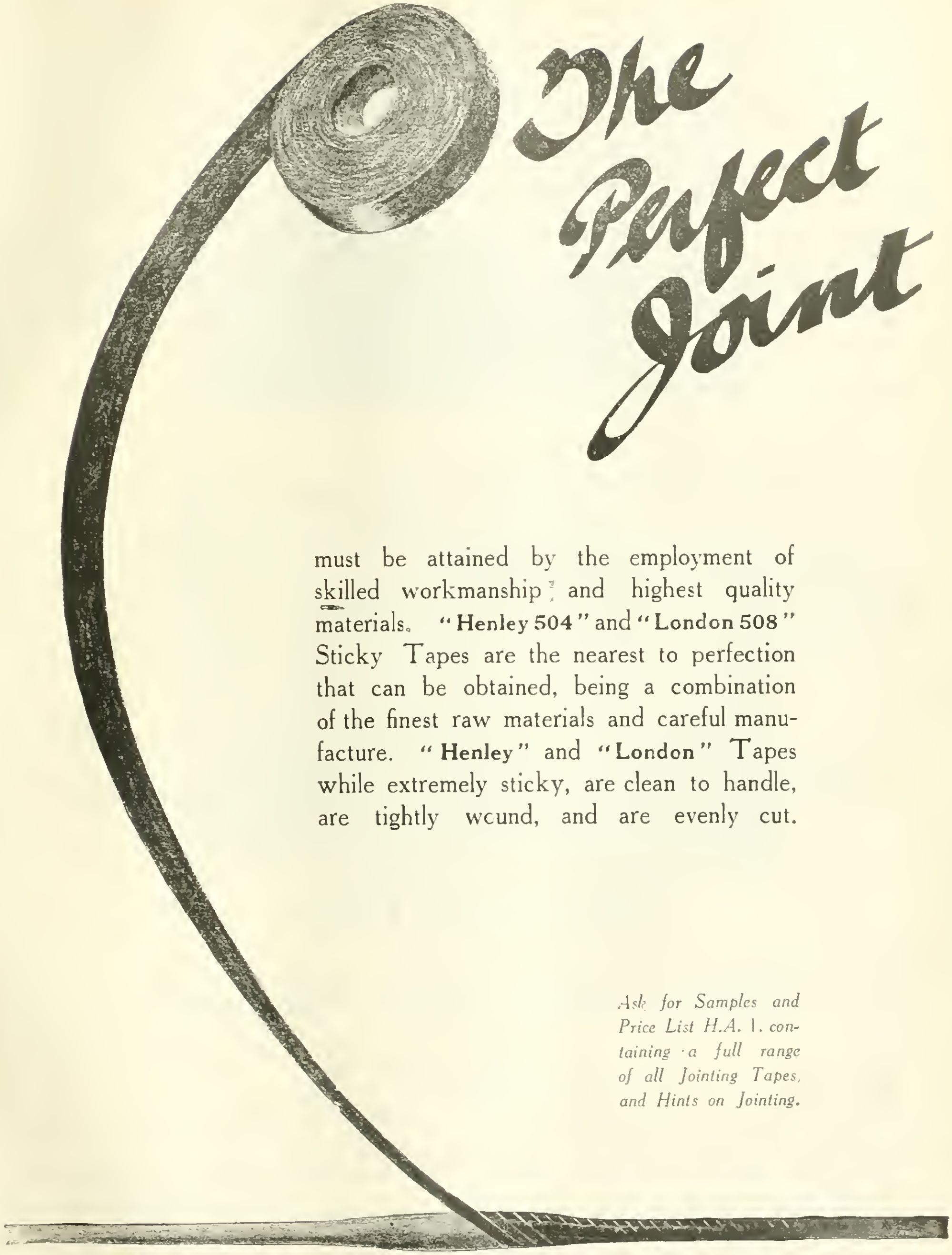

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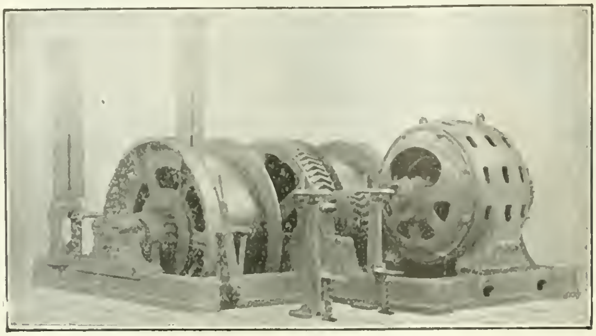

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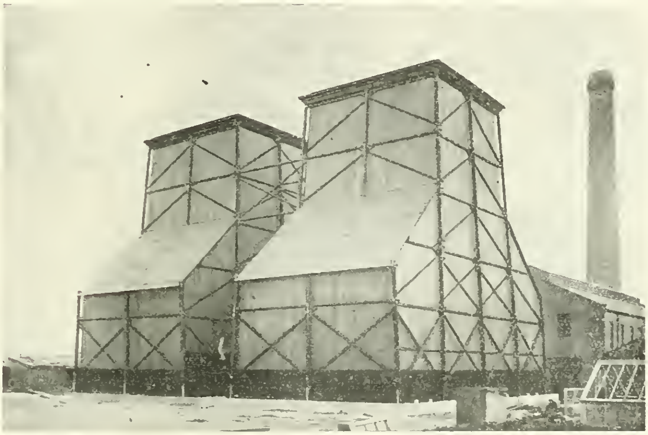

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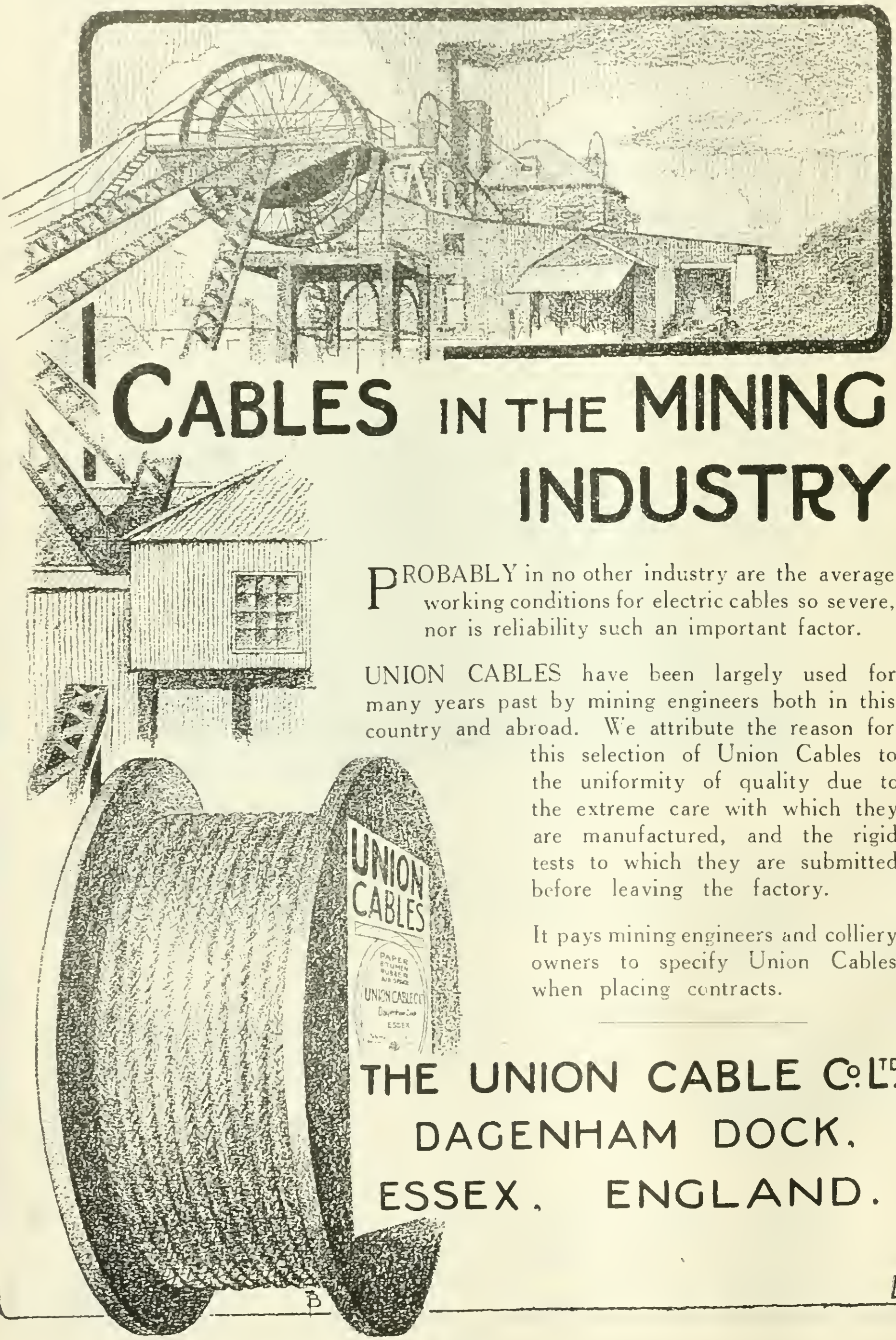

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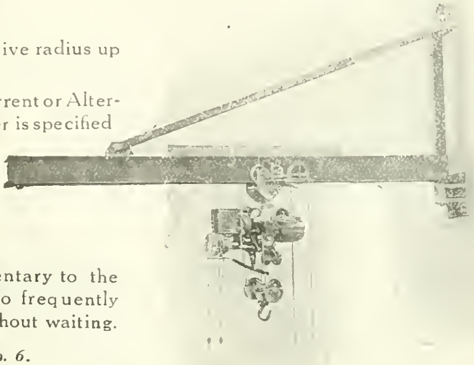

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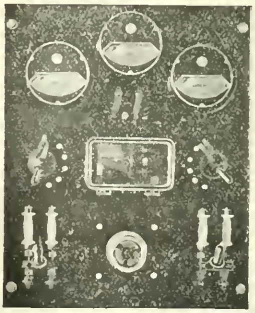

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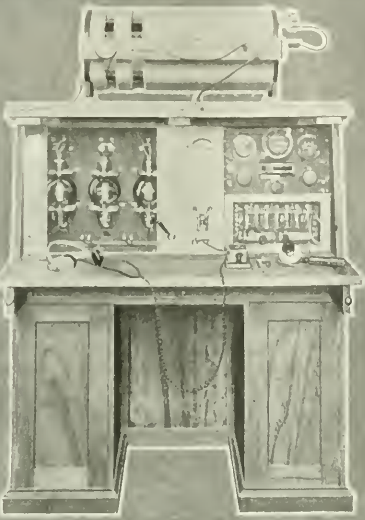

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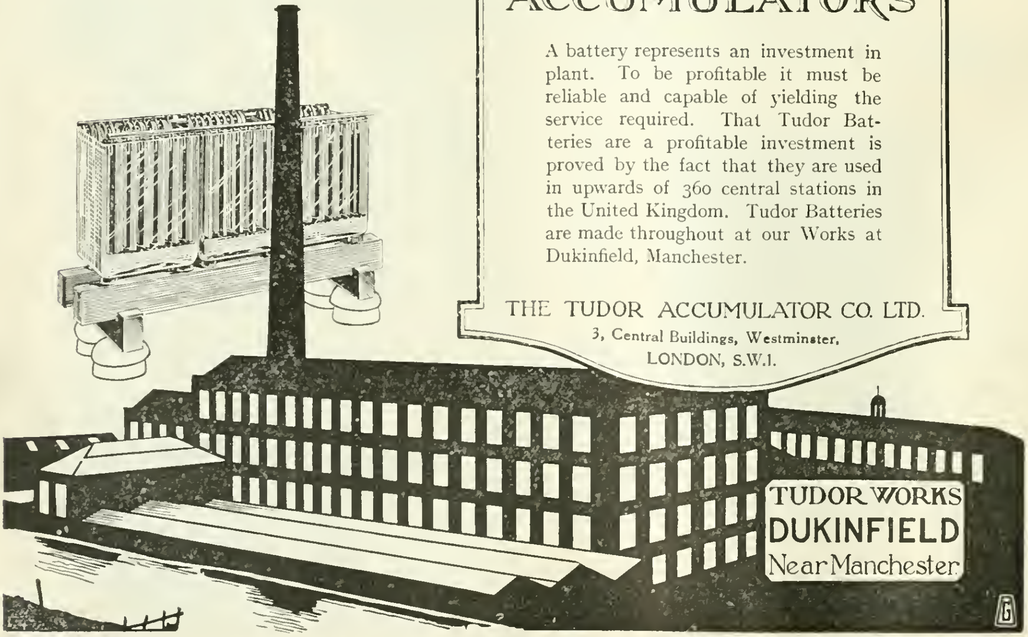

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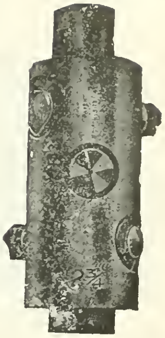

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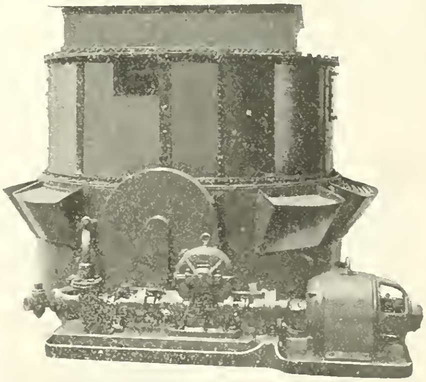

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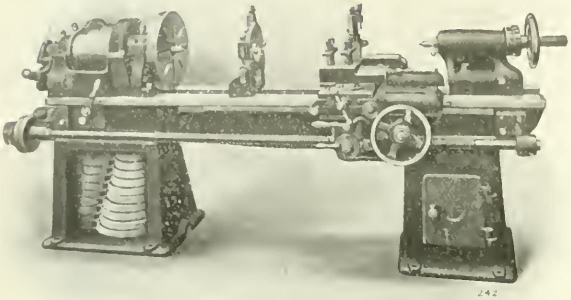

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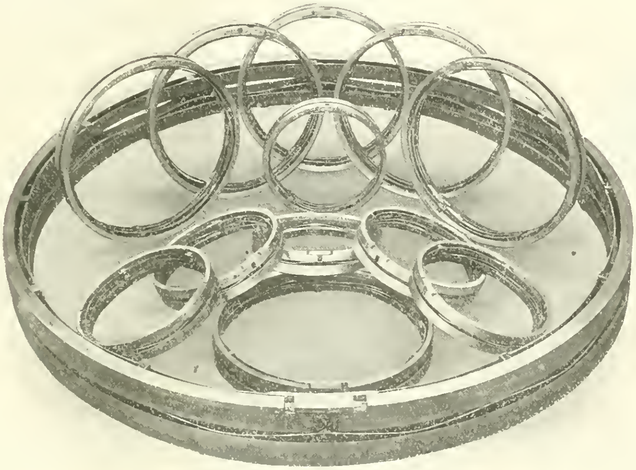

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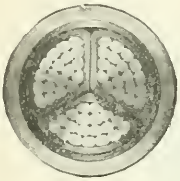

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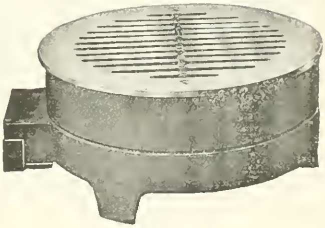

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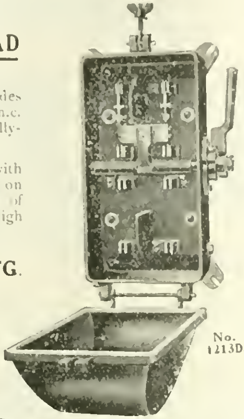

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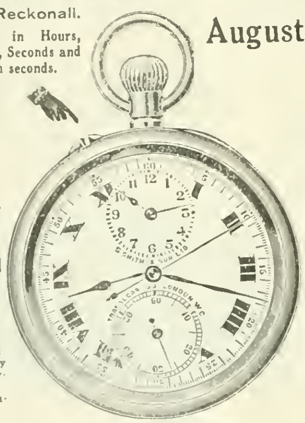

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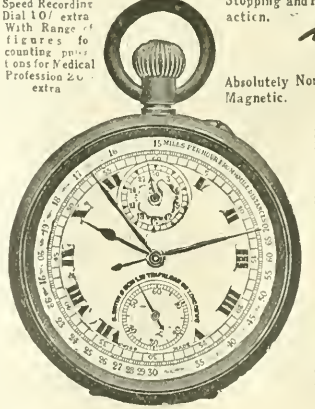

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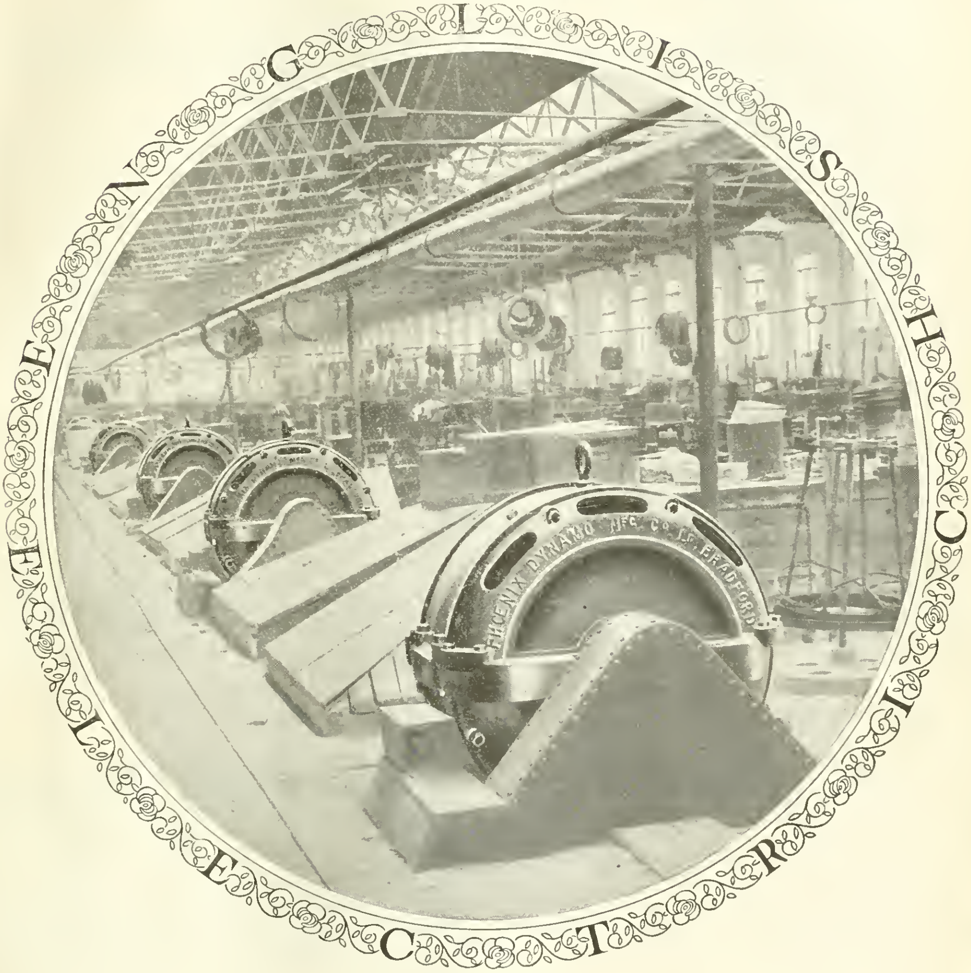

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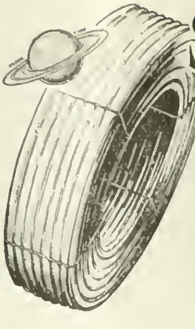

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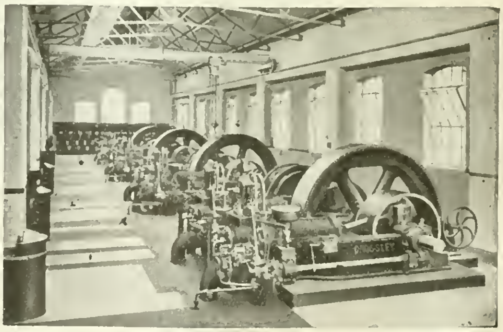

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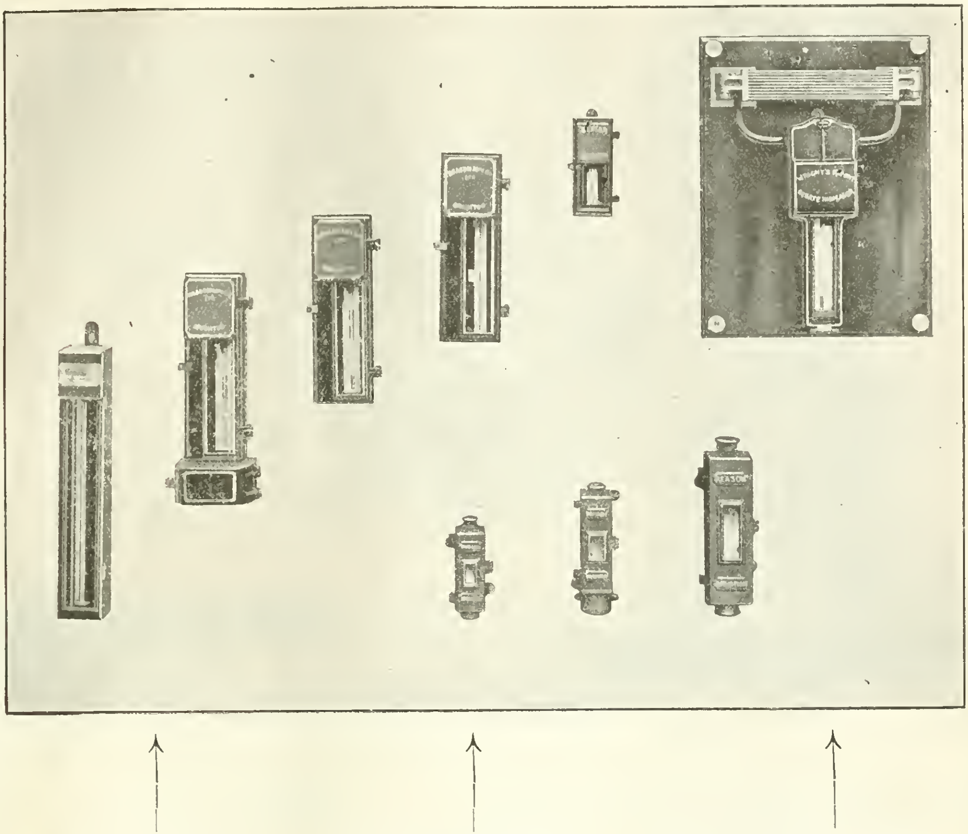

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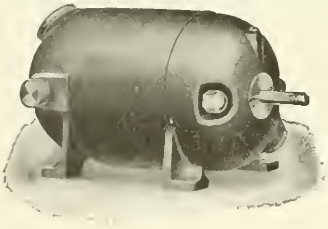

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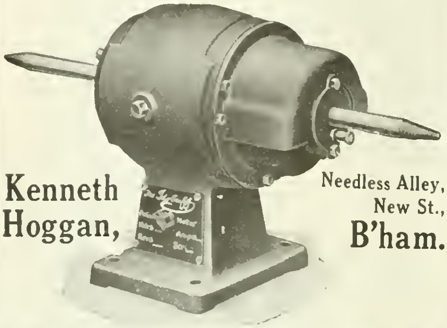

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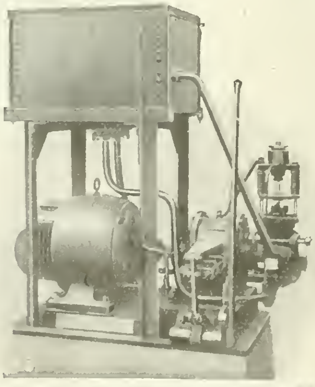

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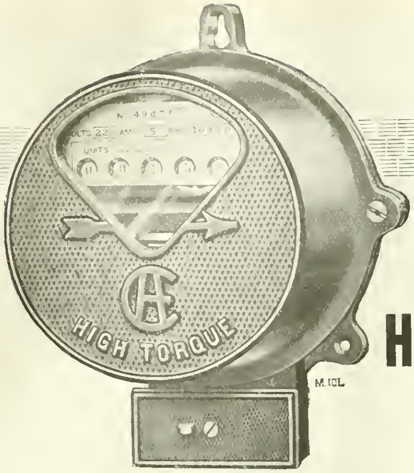

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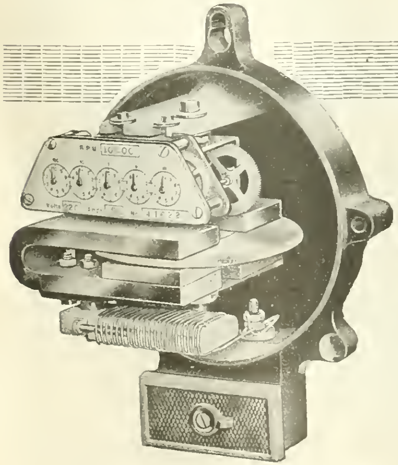

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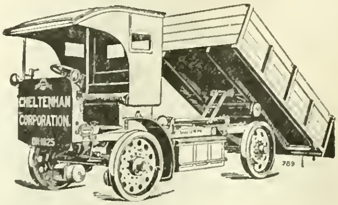

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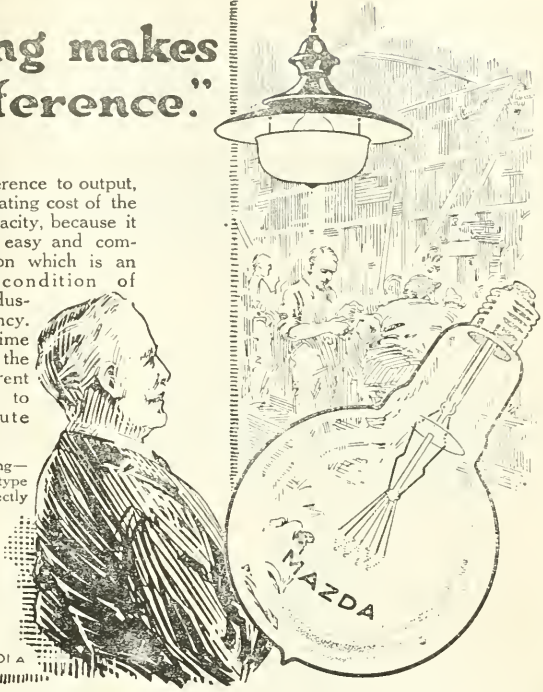

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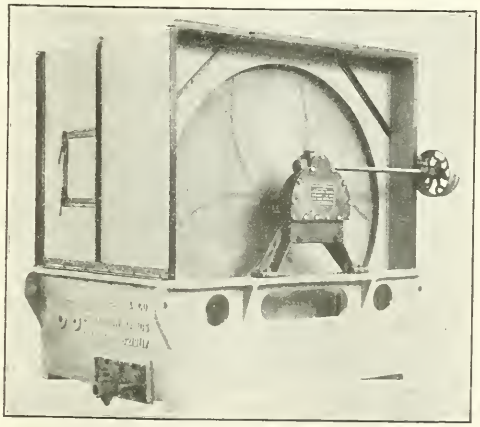

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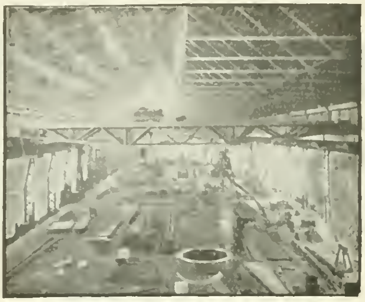

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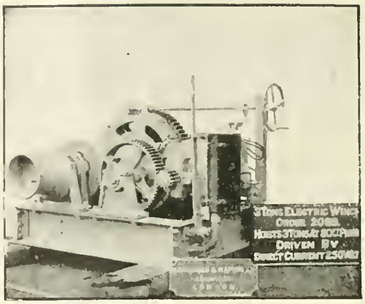

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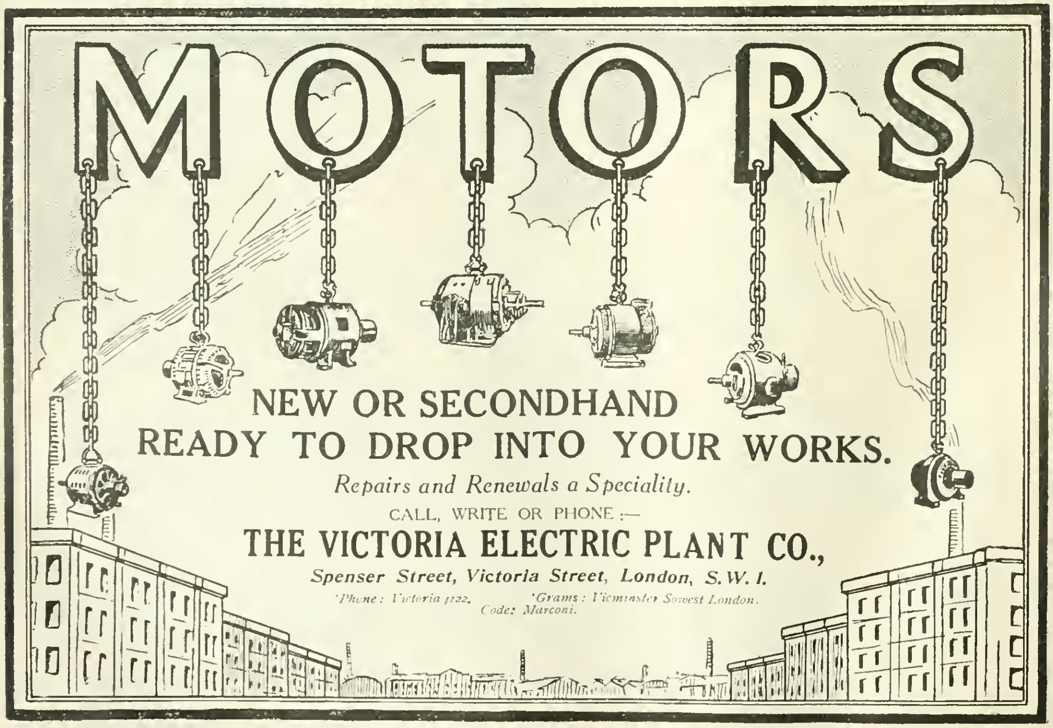

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Any further information can be obtained from the undersigned.

H. BELL,
City Electrical Engineer.

Electricity Works, Sculcoates Lane,
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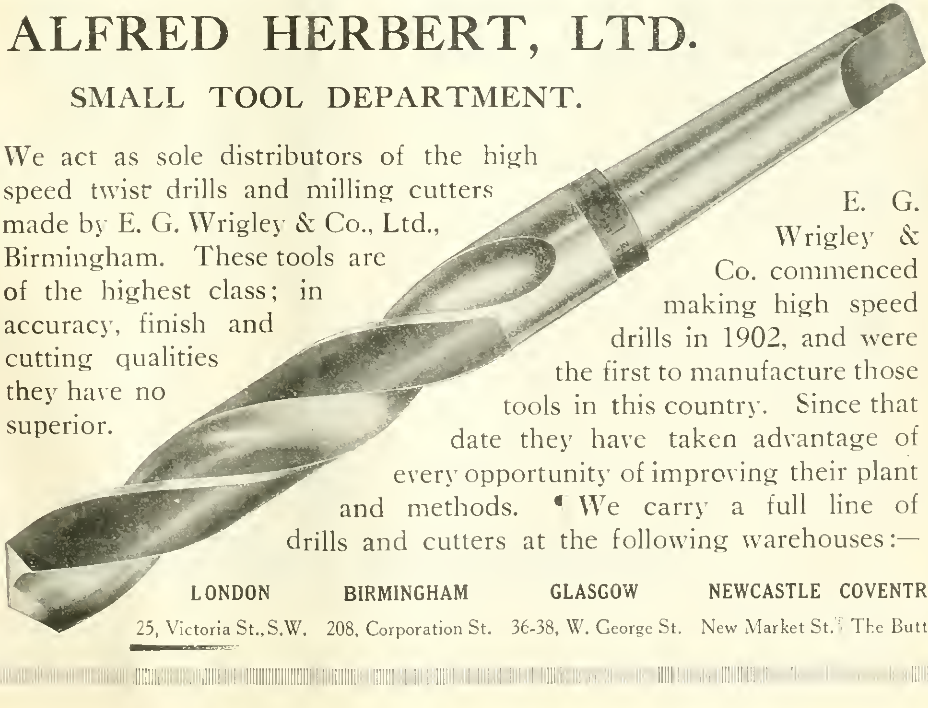

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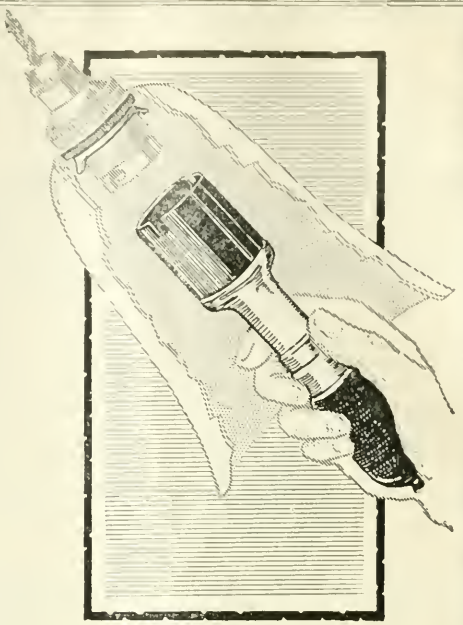

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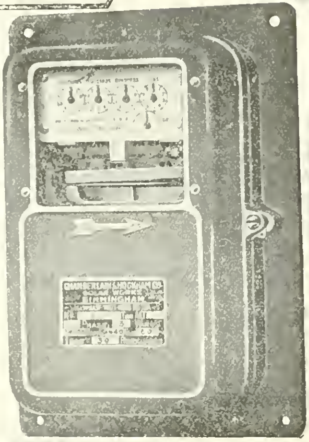

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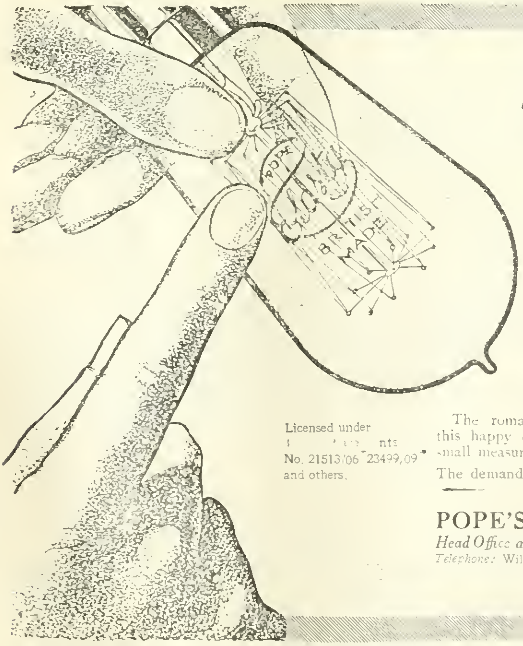

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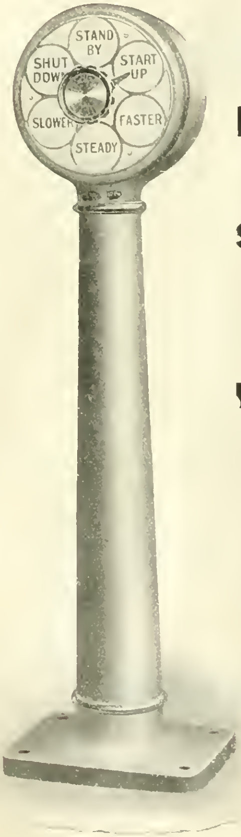

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No. 2,197. [No. 26. Vol. LXXXIV.] FRIDAY, JUNE 25, 1920. PRICE ONE SHILLING. *By Post, 1s. 1d. Abroad 1s. 2d.*

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Notes.

The I.M.E.A. at Bradford.

THE twenty-fifth convention of the Incorporated Municipal Electrical Association opened on Monday last under the most propitious conditions. and, though we write diffidently when it comes to prophesy. we have no doubt that as it has begun so it will go on. and that by the time this issue of THE ELECTRICIAN appears what will have proved to be one of the most successful meetings in the history of the Association will be drawing to a close. The only uncertainty is the weather, which at such an outdoor gathering is a factor of some importance. In accordance with our usual custom, we do not deal with the proceedings at the Convention this week. but in our next issue we shall give a detailed account of all that has happened, together with a number of special articles. the whole forming a record of progress which is likely to prove of exceptional value to those who have anything to do with electricity supply.

The Spirit of the Convention.

LAST year we called the gathering at Ipswich the Peace Convention. At that time industry was still neurasthenic, and even the most energetic were only beginning to look round somewhat fearfully at the multiplicity of tasks that lay before them. Last year there was anxiety; this year there is an air of enthusiasm which it is good to see. There is no doubt that the outstanding feature of this year's Convention is the way in which the minds of all are anxiously exercised as to the future of electricity supply. The more energetic among station engineers are pressing for greater co-operation in supply problems. the more conservative are fearful as to the result of such a policy as affecting both themselves and electricity supply. Generally both classes are quite honest in their opinions. and are, we believe, equally open to conviction and argument. We have no doubt that all phases of this subject have been discussed informally during this week, and we hope as a result it will be possible to formulate a considered policy which is worthy of receiving the support of the Association as a whole.

The Future of the Association,

SUCH a consolidation of thought as a considered policy implies is the more important as the future of the Association itself is not without its difficulties. One thing is certain, it cannot continue to stand where it does at present. It must either go backwards or forwards. Mr. ROLES' appeal to members of the Association for more support will, we hope, be responded to with enthusiasm. The Association has done good work in the past: it would be a pity if its future were in any way less satisfactory: but to ensure this it must be wholeheartedly supported by all those whose interests it represents. Only in this way can it obtain that political influence which we agree with Mr. ROLES is essential to its well being.

Payment by Results.

ONE of the most essential needs of the day is something that will make us all. employers and workers alike, give more thoughtful consideration to the industrial and financial condition of the country. On the one hand, the employers strongly denounce the stupid ca' canny methods and the pernicious policy of limiting the output adopted by some workers: while on the other we have vigorous denunciations of profiteering by trade union leaders and demands for the socialisation of industry. We believe that these mutual recriminations do no good: in fact, they make a bad position worse. It is admitted that increased production is very urgently needed. but it requires a good deal of education and propaganda work to impress this upon the majority of the workers. We are glad, therefore, to see that the Industrial League and Council, which has just held a successful Convention of Employers and Employed at Manchester. is continuing its efforts to bring employers and employed together. By this means each side is given an opportunity of hearing and appreciating the other point of view. and of discussing debatable questions on the same platform. An important item in the Manchester Convention was the reading of a thoughtful Paper on "Payment by Results." by Mr. F. S. BUTTON. who stated quite fairly the objections of the men to its adoption. He pointed out that the national rehabilitation largely depended upon engineering and upon an increased output from the workshops. He went on to give a summary of the premium bonus system, of existing profit-sharing and similar schemes and of their operation. It was significant. he said, that throughout the war no time was lost in any iron and steel works in Great Britain in fighting for advances in wages where a sliding scale had been in operation. If, he asked. a workman agreed to a price for a job. and then by reason of special skill or application, or the perfection of his own tools made his time rate of wages look small, why should his price be cut whilst the employers' price remains unchallenged? Everybody should be encouraged to employ initiative and energy. The system of payment by results was, in the opinion of many of the leaders on both sides, the only sound form of profit-sharing, and he suggested that proposals should be adopted to render easy the introduction of the system in every trade and industry. The employers and the workmen directly concerned must have some real local autonomy in the matter, whilst the central executives, such as now generally existed on either side, should have the right to ask for a measure of uniformity to some central plan for the whole of their particular trade. Co-partnership and profit-sharing were not sufficiently immediate in their results to be a real incentive to workpeople. Some of the schemes under this heading had been disastrous to the organisation of the men, and the bare mention of the name shrivelled up any desire to co-operate. It was too impersonal, too remote, too slow in realisation to stir the mind and quicken the imagination of the average worker. We agree that once the working classes get to believe that a square deal is intended their co-operation will be secured.

The Insurance of Public Supply.

A short time ago we called attention to the need of protecting generating stations from damage, and thus minimising the possibility of urban areas being without artificial light even for a short period. The question which is one to which consideration must be given by those in authority at some early date is, perhaps, not quite so urgent when considered from the point of view of the power user; but even then there are operations where the sudden cessation of power supply would cause a serious financial loss and have other harmful effects. We are not, therefore, surprised to learn that certain manufacturers, while adopting the up-to-date policy of taking the electrical energy they require from the public mains, are also employing a form of insurance by installing gas or oil engines of moderate horse-power which, in event of cessation of supply, can be used to generate the current necessary for lighting the works or driving cranes or other important machinery. Such an arrangement is naturally only an emergency one, the plant installed never being sufficiently large to supply the whole of the works. The rightness or wrongness of such a policy is one that cannot be decided in a general way. Such an arrangement, it is true, ensures that some supply is always available, but it must not be forgotten that both the first cost and running costs of such plant should be legitimately added to that of the power obtained from the public supply. For this reason it may well be argued whether it is worth while to make such provision. Cessation and even reduction of supply are neither frequent nor prolonged. It may well be that any financial loss they cause is less than that expended on the form of insurance we have just mentioned.

The Development of the Telephone System.

A leading daily paper with unconscious humour calls caustic attention in one column to what we suppose must now be termed the Chilwell scandal, and in an adjoining column complains of the delay which is being experienced in obtaining telephone communication between our large towns. We agree that telephone communication at the present time is one of the most essential factors in developing commercial prosperity. The provision of trunk lines in this country has always been meagre, and the war checked what development there was. In order, therefore, that a "cheap and abundant" telephone communication may be obtained, a large capital expenditure on this service is now necessary; and we are glad to see that £10,000,000 is to be set aside for this purpose. When the cry at the moment is all for economy, this may seem a large sum; but there is a difference, which is not always appreciated, between necessary and unnecessary expenditure even in such times as these. Such expenditure as that at Slough, Chilwell and on the Ministry of Transport salaries is, of course, deplorable in every way; but there is another kind of expenditure which brings in its train not only a financial return which in itself makes it worth while, but a general development of our commercial resources. It is in this class of expenditure that the sum which it is proposed to spend on the telephone system may well be placed.

Standardisation of Wiring Material.

One of the objects we should have in view at the present time must be to reduce the price of electrical apparatus and installation work to such a figure as will bring them within the reach of a much larger number of people than is now possible. One of the possible ways of doing this, as the "Electrical Contractor" points out, is by standardising the material used, and so reducing the cost both of its erection and manufacture. Some such arrangement might also have a beneficial effect on the cost of labour, as each man would tend to become more skilled at his job when working on a few operations rather than on a large number; there would be less waiting about, more labour-saving devices could be used and repairs could be more quickly effected. Naturally such an arrangement should have the effect of reducing overhead charges and facilitating storekeeping and supervision. This is the path to progress on which the Electrical Contractors' Association would do well to enter, and we shall watch the results with interest.

The Last of the Surface Contact Systems.

The decision of Wolverhampton Corporation to substitute the overhead trolley for the Lorain system of surface contact traction revives memories of the keen battles which were waged over the most suitable form of electric traction for tramways in the opening years of the century, and it leaves the overhead trolley as the only survivor in this country outside London. At one time it was thought that the Lorain and other surface contact systems had great possibilities, but experience has proved otherwise. On routes where there was heavy vehicular traffic the studs got out of order frequently, and owing to heavy upkeep charges the systems were soon discarded except at Lincoln and Wolverhampton. In the former case the "G.B." system was abandoned last year, and now the Lorain is to disappear from Wolverhampton. Owing to its low first cost and to its flexibility the overhead is now employed everywhere except in London, where the conduit system is in operation on the tramways of the London County Council. The principal objections to the overhead system were based on aesthetic grounds, but as Wolverhampton is a purely industrial town, one would have thought that utility would have been preferred by the civic authorities. However, it has now been found, after 18 years' experience, that it is necessary to make a change for several reasons. The existing costs are somewhat high, irritating traffic delays occur in consequence of frequent breakdowns, and owing to the developing traffic it has become necessary to lay a double track. The overhead is a less expensive system to instal than the existing method, particularly in a case where double tracks are required. In addition it has been found that overhead equipment has become standardised, and as the tendency is towards further standardisation it was deemed necessary to abandon the existing system which necessitated the adoption of special sized wheels, tyres, motors and other equipment. As Wolverhampton wishes to have through communication with Walsall, Dudley and other districts, and as it is also hoped to develop the goods and mineral traffic, it became, therefore, a necessity to adopt a system which would permit through running.

Housing at Hammersmith.

We are glad to see that the municipal authorities at Hammersmith are dealing with the housing scheme in that borough in the right way. In these days, it is not of the least use to spend thousands on erecting houses if that small extra sum which will raise these houses to the modern standard of convenience is stinted. Among those modern conveniences electricity is pre-eminent, and the working man, no less than any other class of the community, is entitled to be provided with that convenience in such a way that he can make the best use of it as cheaply as possible. The Hammersmith Electricity Committee realise this, and not only propose to spend £22,000 on the supply mains to the site, but an additional £5,000 for services on the basis of one service to every two houses. Moreover, to induce tenants to use electrical energy for all purposes, they propose to install a prepayment meter in each house, especially as tenants themselves, for economic reasons, prefer this method. We shall be interested to see how this broad-minded experiment works from every point of view. It certainly possesses the advantage of simplicity.

Production of Electric Lamps in the United States.

Some figures given for the production of electric incandescent lamps in the United States in the "Electrical World" should give makers in this country food for thought. For the year 1919 sales of all kinds of lamps in the United States amounted to 183,000,000, and although this is 3,000,000 less than in 1918, the diminution is not substantial. This, it will be noted, apparently takes no account of the activities of American enterprise abroad; for example, in Germany, where a large share in the A.E.G. is reported to have been acquired; and in Japan, where the influence of the United States on the lamp industry is known to be great and growing. An interesting feature is the diminution in the percentage of carbon filament lamps made (this has fallen from 11 per cent. to 7 per cent. in 1919), and the increase in the use of gas-filled lamps, of which 24,000,000 were sold in 1918, as compared with 27,000,000 in 1919—a rise of 12½ per cent. It is also noteworthy that the average candle-power of lamps sold is still progressively increasing.

Modern "Economy."

One of the definitions of "economy" in Webster's dictionary is "frugality in expenditure," and another is "prudence and disposition to save," while yet a third is "management without loss or waste." From certain of their recent actions we conclude that few of our Government departments read this interesting volume, for there seems among them little clear understanding of the real meaning of that much-abused term. They are particularly spendthrift where printing and stationery are concerned. We recently heard of a case where thousands of forms were destroyed owing to some slight alteration becoming necessary in the heading; and the number of White Papers and Blue Books produced to be sold at a price below cost, or pigeonholed in some dusty basement, is as large as it is unnecessary and distressing. All this is, we suppose, part of that inflated self-importance which seems to possess our new bureaucracy: but we are sorry to see that the Electricity Commissioners are not guiltless of this indictment, for two sets of regulations recently issued by them, and entitled respectively "Regulations prescribed by the Electricity Commissioners under Section Four of the Electric Lighting Act, 1888 (El C12)" and "Regulations of the Electricity Commissioners as to Extra High Pressure (El C 13), on closer examination turn out to be old friends, with the one change that the words "Electricity Commissioners" have been substituted for Board of Trade in a few places. The imprint shows that 1,000 of each of these leaflets have been printed, and we suppose that we ought to be thankful it is not more, for if this is not waste of public money what is?

Goods Traffic on Tramways.

Little use is made of the tramways in this country for the carriage of goods and parcels. This is principally due to the authorities concerned finding it impossible to secure the necessary powers owing to the opposition of the railway companies. In a few cases, such as at Bradford, Dublin, Halifax, Leeds and Manchester, there is a limited service for the transport of mails and small parcels (usually limited to 28 lb. or 56 lb.); but this business has not been developed to the extent it might have been. In this connection, it is interesting to note that a clause in this year's Bill of Halifax Corporation authorises the carriage of merchandise traffic and animals on the Corporation tramways, subject to the consent of the Ministry of Transport. During the war it was found that tramways could be usefully employed in delivering coal and raw materials to factories and workshops, and Halifax is anxious to develop this business. In our opinion, tramways can never become competitors of the railways in the carriage of goods; the tramway traffic will be mainly local, and tramways will really act as feeders rather than rivals of the railways. The gauges of the tramways in this country vary so much that it would be difficult to organise an inter-urban goods traffic. For instance, the gauge at Bradford is 4 ft., at Leeds the lines are constructed on the standard gauge, while at Halifax and Huddersfield the gauge is 3 ft. 6 in. and 4 ft. 7¾ in. respectively.

Gas v. Electricity.

The "Gas World" of February 14, 1920, contains the following challenge from Sir Dugald Clerk to the electrical industry:—"It would give me great pleasure to discuss my Royal Society of Arts Paper [on the 'Distribution of Heat, Light and Motive Power by Gas and Electricity,' read before the Royal Society of Arts in March, 1919, and dealt with in The Electrician for March 28, 1919] and the report of Prof. Smithells, Prof. Cobb and myself [the salient parts of which we publish in this issue] at the Institution of Electrical Engineers, where I could meet competent electricians in friendly debate. The question of future efficiency of both gas and electricity could then be debated in a fair and honourable way." We are glad it was found possible to accept this challenge, and the well-sustained and suggestive debate conducted by men eminent in our profession at the meeting on Wednesday in last week makes us hope that other controversial topics will from time to time be discussed in a similar way.

The Case for the Challenge.

Put as briefly as possible, Sir Dugald Clerk's contentions are: Out of every 100 heat units in the coal used at gasworks 46 are available for the use of the consumer, while out of every 100 heat units in the coal burnt at the generating station and converted to electricity only 8·5 units are so available; that having reached the consumer 18·3 per cent. of the heat units in gas can be utilised for heating as against 4·5 per cent. of those in electricity, or roughly one quarter; that when gas is employed for power purposes 10·9 per cent. of the heat units in it can be utilised, and that when electricity is employed in the same way only 6·8 per cent. are so utilisable; that when gas is used for lighting 203 c.p. hours are produced per 1 lb. of fuel of 13,000 B.Th.U., and that when electricity is used this figure is 241 ; that to supply electricity the number of useful heat units, horse power hours and candle power hours at present furnished by the gas industry for every 100 tons of coal used in gas making, 265 tons, or over 2½ times as many, would have to be consumed at the electricity generating station. It, therefore follows that from the strictly economic point of view the uses of electricity should be confined to provide lighting, and that gas engines and gas stoves should take the place of electric motors and electric radiators.

Some Unjustifiable Figures.

Sir Dugald Clerk's first argument is that 46 per cent. of heat energy in the coal is delivered to the consumer in the form of gas. But this figure takes credit for all the heat contained in the tar and coke ; and the assumption is made that this heat can be wholly recovered. In other words, as our contemporary "Gas" remarks, "credit is taken in a process of partial gasification of coal for a greater efficiency than a total gasification process would give." This is hardly justifiable, and instead of gas being nearly five and a-half times as efficient on this account we are being generous if we admit that it is twice as efficient. This is on the thermal basis alone, for following Sir Dugald Clerk's example we disregard all questions of cost, and leave aside for the moment such factors as adaptability, convenience and cleanliness.

The Ventilation Question.

Coming next to the relative work done by the two agents, Sir Dugald Clerk gives arbitrary figures for gas efficiencies which are most certainly not borne out in actual practice. That is indeed one of the disadvantages of a discussion of this kind, removing it at once from the realms of reality to those of speculation. Compared with electricity, the employment of gas is complicated by all sorts of factors, one very important one in the case of heating being ventilation. Now apparently Sir Dugald's opinion is that the amount of heat from a gas stove which escapes through the ventilating ducts or is otherwise lost is limited to 59 per cent. How it is, or can be, limited under ordinary conditions of use is not clear ; and if it cannot be so limited this great argument in favour of heating by gas must disappear. With electricity the conditions are different, as there are no products of combustion, and an efficiency of 85 to 90 per cent. can be obtained as against the 53 per cent. given by Sir Dugald Clerk.

We agree that this is the most difficult part of the question. Compared with its efficiency as a power agent electricity is at present a relatively inefficient heating agent, and the relative advantages of gas are therefore great. This discrepancy is, however, not likely, in spite of pessimists, to be permanent, and here again thermal factors are not the only things that have to be considered.

Power Figures.

The same disregard of true efficiencies is to be discovered when the figures for power are considered. The efficiency of the gas engine is taken as 25 per cent., but this is the efficiency of a modern engine on full load. Now, as rightly pointed out in the discussion by several speakers, gas engines do not normally operate continuously on full load or anything like it, especially as owing to their small overload capacity the horse power installed, if they are used, has to be sufficient to meet all emergencies. This is not the case with the electric motors, which can be overloaded whose efficiency is both as high and practically constant over a wide range of loads, and by whose use it is possible to save a considerable amount of energy owing to the employment of the direct drive and the consequent reduction of unnecessary and inefficient running to a minimum. Instead of gas being 1·6 times as efficient as electricity it would be more correct to say that even on this basis electricity is more efficient than gas. We are once again considering only the thermal point of view.

The Production of Light.

The lighting figures are interesting. Firstly, because the thermal basis is here forsaken and it is admitted that in the production of light electricity is more efficient than gas. Even then the figures given are less favourable to electricity than they really ought to be. Sir Dugald states that inverted gas mantles radiate 47 B.Th.U. per candle power hour, but taking his own figures this shows that only 63 candle power hours are obtainable instead of the 203 candle power hours clamed by him, while the candle power hours obtainable from 1 lb. of coal by electrical means are more like 1,000 than the 241 conceded. No wonder the modern working man desires electricity in the homes that are shortly to be built for him.

The Drawbacks of such Discussions.

To us it seems that Mrs. Malaprop's much quoted dictum about comparisons is very applicable to this case, the more so that such discussions, though technically interesting, get us very little further along the road to that economy of our fuel resources which we all desire.

As we said over a year ago on this same subject, "If the thermal point of view was the most useful one on which to base comparisons there would be nothing more to be said, and in that case electric power would never have developed to the extent which it has to-day. . . . Actually, however, as everyone knows, electrical plant is used very largely, and to an increasing extent." This point was reiterated over and over again in the course of the discussion—by no one more forcibly or definitely than by Mr. Wordingham.

Finance the True Basis.

The determining factor is, of course, finance. Manufacturers find it pays them to use electric power. The ordinary householder finds it pays him to use electric lighting, as do the theatre and cinema proprietors, the shopkeeper and the street authorities. The owner of the City office even finds it pays him to use electric heating. Moreover, the relative financial advantages of electricity and gas are not to be determined by a comparison of the bills received at the end of each quarter, but by taking into account all the economies and advantages realised by the use of the two agents. In such a comparison electricity scores and will increasingly continue to score in all directions not because the hard-headed business man or the harassed householder is using it as a charity, but because they find that in the broadest sense of the term it pays them to use it.

Lubrication—Theoretical and Practical Problems.

The necessity of introducing between two surfaces, either or both of which may be moving relatively to the other, a film of some substance which will reduce friction and so prevent the loss of power, the generation of heat and excessive wear has been known to engineers from the earliest days of the machine age. It is, therefore, somewhat astonishing that there is so little real scientific knowledge as to why this introduction gives rise to the desired improvement, and as to the properties and composition of the substances by which this improvement can best be effected.

The pioneer work of Osborne Reynolds and Beauchamp Tower in this field is, of course, historic, while more recently Irving Langmuir has done important correlated work on the more theoretical side of the subject by investigating the question of surface films; but, nevertheless, the field is still largely untilled. Lubrication, indeed, is a subject which has been unaccountably neglected, though it bristles with complexities which now more than ever require early solution.

Lubrication and Increased Efficiency.

It is, therefore, a matter for gratification that this subject has been receiving so much attention during the last few months, both on the theoretical and practical sides. The problems that have to be solved are of both a physical and a chemical character, and may equally claim the attention of the chemical engineer as of the physical chemist. Lubrication is a matter upon which not only is our scientific knowledge deficient, but upon which we need, in these economical times, fresh information, so that we may obtain by the use of the best material greater efficiency with the production of less dirt and noise and at a reduced cost.

Two Important Conditions.

In the consideration of lubrication problems there are two important conditions present between which a clear distinction must be made. When two solid surfaces are completely separated by a film of oil, as occurs in the lubrication of machine bearings working under ordinary conditions of speed and pressure, the friction is entirely due to the viscosity of the lubricants, and a measure of this factor and of the chemical characteristics of the lubricant allow an opinion to be formed as to the suitability or otherwise of a particular material for this class of work.

Measurement of Viscosity.

Now, viscosity is not difficult to measure, and there are numerous methods by which its determination can satisfactorily be carried out, including those due to Michell, Saybolt, Engler, Redwood, Poiseuille and others. The composition of the various oils is a matter in which the chemist is more particularly interested than the engineer, who must, of course, be mainly concerned with obtaining the lubricant that is best suited to his needs time after time, with the assurance that when it has the same name it will always have the same properties. The chemist now knows a great deal about the chemical composition of the various oils, so that this particular lubrication problem is relatively simple from both the physical and chemical points of view.

"Oiliness."

When, however, owing to the shape or condition of the surfaces, the kind of motion, high bearing pressure, low speed or an inadequate supply of oil, the oil film cannot form completely, or becomes broken, and the solid surfaces, therefore, come into contact, an entirely different set of problems arise. It is then found that the lubricating value of a substance depends upon some additional property, which has been given the convenient name of "oiliness."

The Effect of Fatty Acids.

This is, of course, of great importance in connection with the lubrication of internal combustion engines, but the problem is complicated by the fact that, so far, it has not been possible to state exactly what "oiliness" is. It has been found, however, that when a straight mineral oil is compounded with a vegetable oil the lubricating qualities of the former are improved, though no reason for this has yet been found. Indeed, it would rather be expected that the opposite would be the case, as the endeavour has always been to refine mineral oils from acid, while the addition of a vegetable oil means the addition of fatty acids which are detrimental to metal surfaces.

The "Germ" Process.

Some interesting experiments recently made by Messrs. H. M. Wells and J. E. Southcombe on this question show that the addition of free fatty acids to a mineral oil results in improved lubricating qualities, and extended trials in the Navy during the war have shown that the new idea of adding fatty acids to mineral oil gave a mixture which satisfactorily performed the functions of the heaviest engine oil compounded with up to 20 per cent. of thickened rape oil. This discovery, which is of the highest interest from both the practical and theoretical point of view, has, somewhat unhappily, been termed the "germ" process, and we think steps should, if possible, be taken to modify this nomenclature, which is unnecessarily confusing. Its value is not, however, reduced by its name, and its development will be watched with interest.

Aqueous Emulsions as Lubricants.

The experiments which we have just mentioned have now been confirmed by Mr. Archbutt, who, however, is of the opinion that the addition of the fatty acids does not really account for the improved oiliness. Experiments on the possibility of using aqueous emulsions for lubricating purposes have been made by Mr. Thornley, and have given the interesting results that such emulsions containing only 25 per cent. of mineral oil have proved perfectly satisfactory under trying conditions. In a particular case a motor, with a no load current of 100 amperes, when using ordinary lubrication required only 20 amperes when using an emulsion of this character. This seems almost too good to be true; but it is sufficient indication that there is a great deal more to be discovered and investigated about lubrication itself, and especially about the substances by which lubrication can best be effected. The comparative value of various solid lubricants has also been the subject of an investigation for the Lubrication Committee by Mr. T. C. Thomsen, and a pamphlet recently issued by the Department of Scientific and Industrial Research contains a useful digest of our present knowledge. Graphite receiving the lion's share of the attention. This substance is sold under various trade names, of which, perhaps, the best known are "Aquadag" and "Oildag," indicating that the graphite is mixed with water and oil respectively. The former has been successfully used as a cylinder lubricant, its employment allowing all troubles due to condensed steam to be eliminated; while experiments at the National Physical Laboratory show that the addition of the latter to mineral lubricating oil is advantageous on worm gearing and other places where solid friction occurs. It is interesting to note that the purer the graphite the better its lubricating properties.

Standardisation at Present a Mistake.

The cry at the moment is for standardisation. This is probably due to the fact that, after years of neglect, the subject of lubrication is now being attacked with almost too great an eagerness and from too many sides at once. From the theoretical point of view this is, perhaps, not of much importance; but from the practical point of view it may lead to confusion, with the consequent adoption of wrong methods, which would be in the highest degree undesirable. As time goes on, more and more useful information will come to light, new and improved methods will be discovered, and old methods, including perhaps many which show great promise at the moment, will be discarded. For these reasons standardisation at the moment would be a mistake. For though it will become desirable as time goes on, and a proper view of how things stand can be obtained, at the present juncture what is wanted is an interplay of ideas, for only in this way can real knowledge be brought to the surface. This is the more necessary as there is sometimes considerable difficulty in discovering exactly what some of the methods at present in use disclose, or are supposed to tell us.

The Thermal Efficiency of the Generation and Use of Gas and Electricity.*

By Sir DUGALD CLERK, K.B.E., D.Sc., F.R.S.

On March 19, 1919, a Paper on "Distribution of Heat, Light and Motive Power by Gas and Electricity" was read by the author before the Royal Society of Arts.† In conjunction with Prof. A. Smithells and Prof. J. W. Cobb, he also prepared a report entitled, "On the Coal, Gas and Electrical Supply Industries of the United Kingdom," which was presented on April 14th in the same year.

An invitation was subsequently conveyed for the question to be debated before the Institution of Electrical Engineers, and at the meeting on June 16th Sir Dugald Clerk accordingly presented an introductory statement based on these two publications. The Paper before the Royal Society of Arts has already been dealt with in THE ELECTRICIAN.† In his introductory statement Sir Dugald Clerk also presented the conclusions arrived at in conjunction with Profs. Cobb and Smithells in tabular form, and they are reproduced herewith.

The conclusions set out in the report may be briefly summarised as follows:—

1. The gasworks of the United Kingdom carbonise 20 million tons of coal per annum, producing gas, coke, tar and other by-products, with a thermal efficiency of from 70-80 per cent. Even regarding gas as the only useful product and allowing for all losses, consumers receive as gas at least 45 per cent. of the heat value of the coal used at the gasworks.

Of every 100 heat units in the coal so used, 55 are lost in gas-making and distribution and 45 are available for the consumer's use.

2. The electricity generating stations of the United Kingdom, including electric railways, deliver 7·6 per cent. of the heat of combustion to the consumer. Losses in boilers, turbines, and thermodynamic conversion of heat into work and transmission account for over 92·0 per cent. of the total heat.

Of every 100 heat units produced in the central station boiler furnaces, 92 are lost and only 7·6 available for the consumer's use.

3. *Gas thus distributes* 45 *units of heat out of* 10 *at the gasworks, instead of* 7·6 *units of heat out of* 100 *consumed at the central station to produce electricity.*

4. The best existing electricity generating undertaking in the United Kingdom delivers 12 per cent. to the consumer and loses 88·0 per cent. In the future super-stations a delivery of 17·6 per cent., 82·4 per cent. loss is anticipated.

5. The best existing gas practice in the United Kingdom delivers about 53 per cent. of the heat in the coal used at the gasworks, and only loses 47 per cent. in generation and distribution.

In the early future, all gasworks could distribute as gas to the consumer one-half of the whole heat of the coal carbonized, leaving 33⅓ per cent. of the whole heat in the unused coke and tar, thus realising the high thermal efficiency of 75 per cent. in the gasification process.

6. *Thus, in the future, gas might be expected to deliver* 75 *heat units out of every* 100, *as compared with the* 17·6 *to be delivered by the prospective electricity super station.*

7. Except where temperatures above 1,700 C. are required, electricity is extremely wasteful of fuel, when applied to supply heat. Gas is superior in the great mass of heating operations.

8. For lighting and power production, electricity promises future results which compare more favourably with gas, but even here the higher efficiency of the gas engine as compared with the steam engine, the probable future economies in gas production, and its use with incandescent mantles render any monopoly claims of the electrical industries unjustifiable.

9. Electricity is an efficient and convenient means of transmitting power and producing light. It is indispensable for electric railways, for transmitting power within works. It is required for many high temperature electro-chemical processes and for all electrolytic processes, so that it fills an increasingly important field. But it cannot economically displace gas for heat, light and power.

DISCUSSION.

The PRESIDENT said the Institution was very glad to have the opportunity of welcoming Sir Dugald Clerk and Profs. Cobb and Smithells. Certain rather acrimonious criticisms had appeared in the technical Press, and Sir Dugald had been anxious that there should be a discussion on rather a different basis. The Institution of Electrical Engineers was equally anxious that the discussion should be raised to a higher plane; firstly, to see if they were agreed about the facts, and, if not, on what they were agreed; but chiefly to emphasise that they were all engineers or scientific workers engaged in the discovery of facts and their discussion, and trying to understand each other's point of view. The deductions they made from the facts might be different, but they wanted to be agreed as to the facts themselves.

Mr. C. H. WORDINGHAM did not propose to enter into any criticism of the figures. As Sir Dugald Clerk had said, electricity was not a source of energy, but might be termed a gearing placed between the fuel and the consuming devices for utilising the energy of the fuel. As a gearing, it should be judged not only by efficiency, but by its convenience and adaptability. Not only was it convenient, but the economy in heating was higher than would appear from Sir Dugald's figures, while motors could do the same work with a smaller expenditure of energy than gas engines. This adaptibility of electrical energy was of the greatest possible importance. The controversy between the advocates of gas and electricity reminded him of the food question. The average man preferred roast beef to beans, and asparagus to cabbages, notwithstanding relative prices. He (Mr. Wordingham) considered that electricity was the roast beef and asparagus in the present controversy. The proper policy was a combination of the two industries. Large gas engines in this country were under a cloud, perhaps because they were largely of German design; but there was hope for British designs, and, if the limiting efficiencies mentioned were realised, they would get the advantages of the superior economy (if there was that economy) of the gas engine combined with the superior advantages of electric gearing. That was what the public wanted.

Prof. J. W. COBB said neither the gas nor electrical industry wanted a stage of development where it was advisable to stereotype its methods and equipment. To put down very large stations and works all of very much the same type, representing the same degree of development, would lock up enormous capital and hinder progress for many years. During the war the separation of helium seemed to have established the probability of very much cheapened methods for the production of oxygen, and his colleague (Mr. Hodsman) and he had been calculating what it would mean for the gas industry if oxygen were so far lowered in price that it could be used in a continuous gasification process. They calculated that complete gasification could then be effected with an efficiency of gas production of 90 per cent., and the consumer could be supplied with a gaseous fuel in the production of which only 10 per cent. of the original heat of the coal had been lost. He referred to this as illustrating the position that the future developments of the electrical industry or gas industry could not be foreseen, and that each should have freedom to develop according to its needs and its capacities for public service.

Mr. C. H. MERZ said the primary object of the Coal Conservation report was to deal with economy of fuel in the production of motive power, though there were some references to the use of electricity for heating. Sir Dugald Clerk and his colleagues immediately took the whole report, and referred to it as if it dealt with heat energy. Now, care had been taken to separate out the fuel used for heating purposes in industry. The next criticism was that the report recommended the setting up of 16 large stations to supply the whole country; but all the report recommended was that the country, for standardisation, should be divided into suitable electrical districts. Nobody on the Coal Conservation Committee ever dreamt of only one station supplying each area. The figures of 17 and 18 per cent., which had been named as the possible efficiency of electrical stations in the future, were being obtained daily in stations in this country and in America with the use of very inferior fuel. If the fuel were taken at anything like the quality put down for purposes of calculation in the Coal Conservation report, efficiencies much higher than 18 per cent. could be obtained. Sir Dugald Clerk had taken as his basis of calculation thermal efficiency, but the whole question was how could labour be used to the best advantage? Coal was only labour for practical purposes, and industrial processes were labour. On an average their motive power only cost from 5 to 10 per cent. of their labour bill. The manufacturer must have his motive power in the most available form; no improvement in coal conservation could be expected if he did not. Dr. Ferranti was right when he said that through electricity energy for motive power could be supplied in the form most difficult to waste or to use improperly. It was important that machines which did not automatically maintain their highest efficiency, and which required attention and skill, should not be put into the hands of the man in the factory. Sir Dugald Clerk had referred to gas engines having test-efficiencies of 20 to 25 per cent; but if gas engine efficiencies were anything like that figure, the efficiency of the electric motors must be 200 per cent. The Coal Conservation report did not suggest that the gas industry should disappear. In other places, where the use of electricity had been developed largely—for instance, in Chicago—the gas industry had not suffered. The more improvements in the carbonisation of coal, in the gas producer, gas engine, gas turbine and so on were encouraged, the better for the electrical industry. Some of the largest gas stations in the world had lower efficiencies, year in and year out, than those given for electrical stations. He would be glad if Sir Dugald Clerk would produce figures to the contrary—not based on estimated output, but actual figures.

Mr. J. S. HIGHFIELD said if the thermal efficiencies given in the Paper were the determining factor between gas and electricity, then, except for lighting, electricity would not be supplied. But gas had started its

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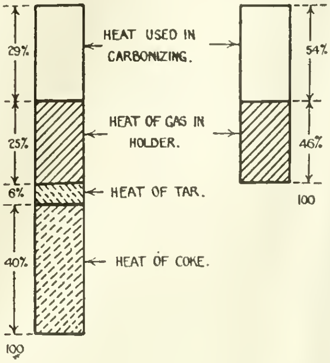
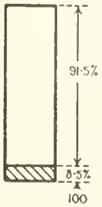
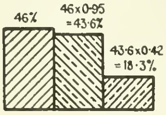
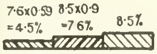
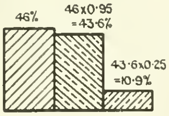
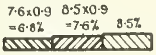
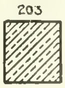
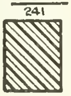
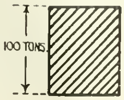
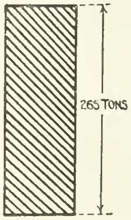
* From a Paper read before the Institution of Electrical Engineers.

† *See* THE ELECTRICIAN, Vol. LXXXII, p. 357.

GAS.	ELECTRICITY.	COMPARISONS.
		$\frac{\text{HEAT CONTENT OF GAS.}}{\text{HEAT EQUIVALENT OF ELECTRICAL ENERGY.}} = \frac{46}{8{\cdot}5} = 5{\cdot}4.$
	HEAT. 	$\frac{\text{UTILIZED HEAT UNITS BY GAS.}}{\text{" " " " ELECTRICITY.}} = \frac{18{\cdot}3}{4{\cdot}5} = 4.$ (APPROXIMATELY.)
	POWER. 	$\frac{\text{UTILIZED HEAT UNITS BY GAS.}}{\text{" " " " ELECTRICITY.}} = \frac{10{\cdot}9}{6{\cdot}8} = 1{\cdot}6$
 CANDLE-POWER HOURS PRODUCED BY THE CONSUMPTION OF 1 LB. OF 13,000 B.TH.U. COAL AT THE GAS WORKS.	LIGHT.  CANDLE-POWER HOURS PRODUCED BY THE CONSUMPTION OF 1 LB. OF 13,000 B.TH.U. COAL AT THE GENERATING STATION.	$\frac{\text{C.P. HOURS PRODUCED BY GAS.}}{\text{" " " ELECTRICITY}} = \frac{203}{241} = 0{\cdot}84.$

COAL CONSUMPTION FOR EQUAL PERFORMANCE.

GAS.	ELECTRICITY.	COMPARISONS.
		TO SUPPLY ELECTRICALLY THE NUMBER OF USEFUL HEAT UNITS, HORSE-POWER HOURS AND CANDLE-POWER HOURS AT PRESENT FURNISHED BY THE GAS INDUSTRY, FOR EVERY 100 TONS OF COAL USED IN GAS MAKING 265 TONS WOULD BE REQUIRED AT THE ELECTRICITY GENERATING STATION $\frac{\text{COAL CONSUMPTION AT GAS WORKS.}}{\text{" " GENERATING STATION.}} = \frac{100}{265} = 0{\cdot}377.$

career before electricity, and electricity had worked its way up to its present position, so it was clear that thermal efficiency was not the determining factor. Further, cost was not the determining factor. If they assumed an efficiency of 100 per cent., and took electricity at 1½d. per unit, gas at 4s. per 1,000 cubic ft. and coal at 40s. a ton, for an expenditure of 1d. with electricity they could evaporate 2·3 lb. of water, with gas 12·9 lb., and with coal from 60 lb. to 70 lb., so that, even the cost was not the determining factor, otherwise no gas would be sold. He was interested to note that Sir Dugald Clerk in all his illustrations contemplated the replacement of gas by electricity, in spite of the fact that by so doing, according to his figures, the expenditure of coal would be increased. But to talk about the scrapping of gasworks and the replacement of gas supply by electricity was out of the question. Gas works would continue to grow, and it was to everybody's benefit that they should do so. For the supply of power over a wide area gas would have no chance. On the other hand, the supply of electricity to small cottages for cooking purposes was probably equally impossible at present. Gas could serve electricians by providing a better means for changing the heat energy of the coal into power.

Mr. C. P. Sparks said their friends of the gas industry had been led into errors through analysing the electrical industry without understanding their real bearing. He regretted that the Coal Conservation Committee's report had not been read or examined before such references were made to it. Reference had been made to the estimated saving of 55 million tons of coal per annum through supply of electricity for heating, but this figure did not include coal used for heating purposes. The estimated saving had been based on 1 lb. of coal per electrical horse-power-hour. He found on referring to the report that the figure should be 1⅓ lb. On that basis the report indicated that they had to have a power station with a thermal efficiency of 17¼ per cent., as compared with the 19·6 per cent. given by Sir Dugald. As had been pointed out, that figure had already been passed. Up to the present a suitable prime mover had not been devised. Gas for power was not comparable with electricity. It was not available for detail drive in factories. Even in Pennsylvania, where Nature supplied the gas works, two of the most prosperous electric power companies in the world were supplying motive power. Sir Dugald Clerk said the gas engine would run at 75 per cent. full load all the time. With small units that was not an operating condition. Taking him on his own figures, if the electric motor was supplied from a modern power station, he was of opinion that the difference, instead of being 30 per cent. in favour of gas, was only 6 or 7 per cent. With the improvements in view, even of the steam turbine, that 7 per cent., if it existed, was going to be wiped out. With regard to lighting, Sir Dugald Clerk had done them honour by suggesting that the efficiency was something like—gas 1, electricity 0·84; but he had analysed the figures, and found it was much greater in favour of electricity than that. He took, in the case of gas, half upright and half inverted burners, and in the case of electricity half metallic filament lamps and half so-called half-watt lamps, and he found the ratio to be 1 for electricity and 2·15 for gas. Electricity was not in competition directly with gas for heating. It came into the heating field only for special purposes, where high temperature was required, or where its thermal efficiency was offset by the higher efficiency of detail apparatus.

Mr. W. H. Patchell said Sir Dugald Clerk's attack should have been made on the politicians, whose interests had been aroused by the report, and not on the electrical industry. For the utilisation of power over large areas the efficiency of gas engines was as nothing compared with electric motors. The facts were known by the gas people. He referred to a Paper read by Mr. Fisher before the recent meeting of the Institution of Electrical Engineers. The writer was an ardent gas man, and firmly believed that there was a great future for gas, provided that the supply was good, efficient and in a true sense cheap; but, in spite of this, five years of electricity supply as a part of his work had shown him that many people would have electricity for lighting if they could get it, even it it cost more, and he had also been astonished at the eager demand experienced for small motors for trade purposes. Motors were used by people who could not be trusted to attend to a gas engine, and the small amount of attention and upkeep they required was agreeably surprising. He also said that shopkeepers who introduced electricity for window lighting extended it to the interior of their premises. They installed half-watt lamps freely, and this brought about an increased demand for current. Shopkeepers who had not adopted electricity were forced to do so by the brilliancy of their neighbours' lighting. There was a decided advantage from the coal conservation point of view in using gas to generate electricity instead of burning it directly in an incandescent mantle. With regard to power, the electric system was preferable in all cases where there was not a continuous heavy load. The competition of electricity had been the making of the gas industry. Each could quite well help on the other. There was room for both, but each should set itself against the pampering of its customers at the expense of the undertakings or of the State.

Col. R. E. B. Crompton said cooking was an inefficient operation with an ordinary coal fire, but when they used gas it was appallingly inefficient. Only about 6 per cent. of the energy went into the food. That was an easily ascertainable figure. He had nothing to learn from the gas company about gas heating of water to supersede his present coal apparatus. He made a bill out of the proper thermal units he would require for water supply to bath, wash-up water and so on, and saw that an enormous waste took place by coal or gas heating. The loss was nearly entirely losses by radiation. He proceeded to his friend Mr. Druitt Halpin, and made a thermal storage apparatus, and showed it to Dr. Carpenter's experts. He used so little gas to heat 16 gallons of water that it did not run the meter. When he saw the small beads of gas which could maintain a mass of water at the required temperature the whole day long, he saw he had something good. He got 90 per cent. efficiency on his gas heating apparatus.

On Cooling Towers.

By Prof. F. K. Th. van ITERSON (Heerlen, Holland).

For the economical working of an electricity station that is without a natural supply of fresh cooling water, effective cooling towers are essential. But in such cases steam consumption is 7 to 13 per cent. more than where there is abundance of fresh water. The lower figure can only be reached when ample cooling towers and large condensers are used, and the average steam consumption of the plant may then be 14·3 lb. per kilowatt-hour. For each degree Centigrade that the water flowing from the condenser to the tower is reduced in temperature, the steam consumption decreases by 0·6 per cent. (⅓ per cent. saving of steam for each degree F.). It is usual for the water to leave the condenser and enter the cooling tower at a temperature of 100 F., and it is possible to get an average temperature taken over the whole year of 90 F., giving an economy of 3·3 per cent., so that with steam at 10s. per ton the costs of a cooling tower of ample dimensions are earned in 10,000 hours, or about two years.

High Efficiency Important.

This calculation shows that the initial cost of cooling towers is of minor importance, but that a high efficiency must be aimed at. Large towers with large collection tanks will be most satisfactory where sufficient ground space is available. Only where the value of floor space is limited is a forced draught cooling tower (of the Wheeler-Barnard, Henry R. Worthington, Heenan & Froude types) to be preferred.

But notwithstanding long experience there is still a great difference in the efficiency of existing cooling towers, and the guarantees given by the builders are often not attained and are sometimes unattainable for physical reasons. A thorough investigation into the performance of a cooling tower is instructive, for faults are often detected, and in many cases improvements can be suggested.

As the conservation of coal is of the utmost importance, in these days attention may well be given to this subject.

One of the most important instruments for examining the behaviour of the tower is the dry and wet bulb thermometer. These are such useful instruments that a brief account of their application to daily engineering practice may be of interest. The wet bulb thermometer of course indicates the cooling limit of the atmosphere, or the extent to which water may be cooled by pouring it through the air or by blowing air through it.

It therefore indicates the cooling limit of the air, and thus enables us to ascertain the performance of a cooling tower, for by entering the tower and examining the air emerging from the cooling stack it becomes possible to detect the deficiencies in their working.

A Dutch Installation.

Fig. 1 is a photograph of the cooling towers at the central station of pit "Emma" (Dutch State Collieries) at Heerlen. Their construction and internal arrangement were the result of investigations made with several cooling towers of first class firms. Some features of the new cooling towers and the considerations on which these are based may be described here.

In the sketch of the section (Fig. 2) the wooden laths are not drawn to scale, because their smallness would make them difficult to discern. This design of tower is an attempt to balance resistance to air flow and maximum cooling surface. The sketch shows how by a suitable arrangement of the lath the air passages were made as free as possible. The dry and wet bulb thermometers show that the air emerges almost saturated and sufficiently heated to cause a good draught. Many other cooling towers give too much resistance. The saturation with water-vapour and the heating of the air not immediately in touch with the falling water, are caused by diffusion and by the whirling of the air. The splashing water and the passages through the laths make it an easy matter to moisten and heat the air throughout. But it is very difficult to get an almost even temperature of the air on any spot above the timber hurdles.

Design of Spray Nozzles.

As it was not possible to make the stream lines of air equal in length, uniformity in the conditions of the heated moist air over the whole surface of the cooling-stack was obtained by increasing the density of the spray from the centre to the periphery. The radially placed gutters are slightly inclined, and the pitch of the spray nozzles is made smaller at the outer rings than at the middle rings.

The maximum cooling capacity is only acquired by adjusting carefully the dispersion of the sprinklers. Some inequality is unavoidable in heavy gales. But in this respect the cooling tower of circular section behaved well enough, and it was found that with large towers the best results were obtained when the radial screens, which, as first designed, divided the tower into sections, were removed. A cooling tower requires frequent and regular supervision. This must be effected by means of the dry and wet bulb thermometer. In a large plant a special carpenter must be trained to repair the often-recurring faults. The man is well paid by the coal he saves. A water softener of ample dimensions must be installed when only hard water is available, and the collecting tank must be emptied and the water renewed at least once a year before the winter. The lath work of many cooling towers has collapsed by becoming covered with deposit.

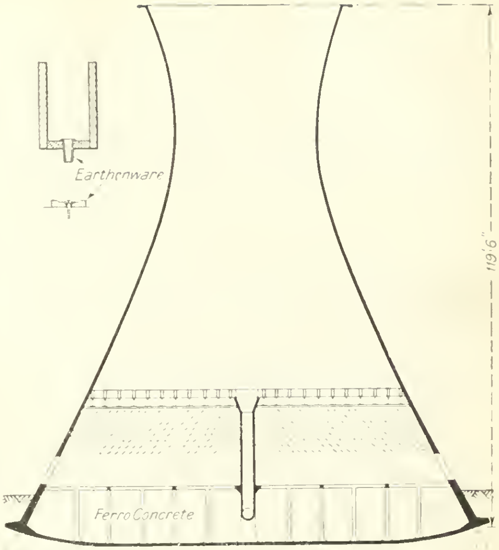


Fig. 2. Diagrammatic Section of Cooling Tower.

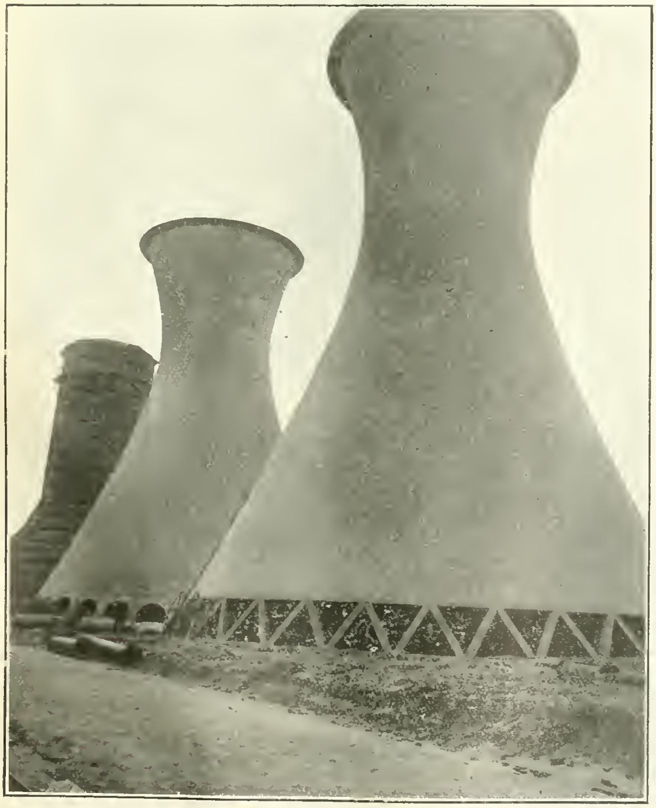


Fig. 1.—View of the Cooling Tower at a Dutch Coal Mine.

Official Tests.

The results of the official tests of one of the cooling towers at the "Emma" pit are given in the table on p. 692.

Attention may be drawn to the fact that there is only a small drop in the temperature of the water flowing through the cooler. But this drop of temperature, this range of cooling is no proof of the inefficiency of the tower. The drop in temperature is always equal to the rise in temperature of the water flowing through the condensers. The small drop in temperature only indicates that a large amount of circulating water is pumped through the condensers. About 60 lb. to 70 lb. of water are used for each pound of steam condensed. In this case the rise in temperature can never be more than 13·5°F. to 14·4°F. however badly or however well the cooling tower is constructed. A large amount of cooling water has a double advantage. The water leaving the condenser and entering the tower is at a lower temperature, and a better vacuum can therefore be attained. Moreover, one is compelled to use large cooling towers, because in a small tower the gutters would throttle the passage of the air. Large cooling towers and a large amount of circulating water are essential, owing to the low temperatures of the water entering the towers.

—	Date of Test, 1919.			
	April 9th.	April 30th.	May 9th.	June 18th.
Temperature of water entering cooler*	31·5 C. 88·7 F.	23 C. 73·7 F.	33·5 C. 92 F.	37 C. 98·6 F.
Temperature of water in collecting tank	25 C. 77 F.	17 C. 62·6 F.	27 C. 80·6 F.	29 C. 84·2 F.
Temperature of atmosphere	10 C. 50 F.	5·5 C. 41·9 F.	15 C. 59 F.	21°C. 70° F.
Temperature of wet bulb thermometer (limit of cooling)	8 C. 46·4 F.	4·5 C. 40·1 F.	14 C. 57·2 F.	18·5 C. 65·3 F.
Degree of saturation	76 per cent.	85 per cent.	90 per cent.	80 per cent.
Temperature of hot air above hurdles (average of 40 observations)	26·7 C. 80 F.	19·8 C. 67·6 F.	28 C. 82·4 F.	30·4 C. 86·7 F.
Quantity of circulating water	2,900 m³ hour. 640,000 gallons.	2,000 m³ hour. 440,000 gallons.	2,300 m³ hour. 506,000 gallons.	1,950 m³/hour. 430,000 gallons.
Heat transmitted	18,800 ton cal. hr. 74,600 B.T.U./h.	12,000 ton cal.hr. 47,700 B.T.U./h.	15,000 ton cal.hr. 59,500 B.T.U./h.	15,600 ton cal.hr. 61,800 B.T.U./h.

It is an easy matter to get a large transfer of heat in a small cooling tower. One has only to use a small condenser or a jet condenser with a restricted amount of condensing water. The draught of air through the tower is very much increased when the difference in temperature of water and atmosphere is larger. Moreover, the transfer of heat between the dropping water and the air is proportional to the difference of the temperature of the water and the cooling limit (wet bulb) of the air. It is absurd, however, to judge a cooling tower by the heat it transfers. The most important condition for a good vacuum, and therefore for a high efficiency of the generating plant, is that the difference in temperature of the water *entering* the tower and the cooling limit of the atmosphere is as small as possible.

The Cooling Tower as an Hydraulic Apparatus.

A cooling tower is an hydraulic apparatus, and therefore it cannot be much overloaded. The cooling towers described in this article are each rated 6,000 kw., or 550,000 gallons per hour. The gutters are normally filled to about two-thirds of their depth, and as the water level rises with the square of the discharge through the nozzles the cooling tower can only be overloaded 25 per cent. before the gutters overflow. The maximum capacity of the tower represented is about 700,000 gallons per hour. It is quite possible to overcharge a cooling tower much more than this, but the overflowing of the gutters is very bad for the efficiency.

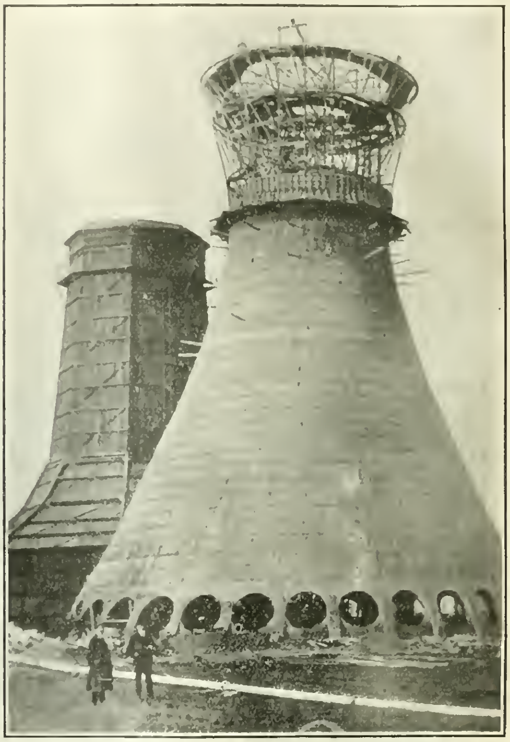


Fig. 4.—A Concrete Tower in Course of Construction.

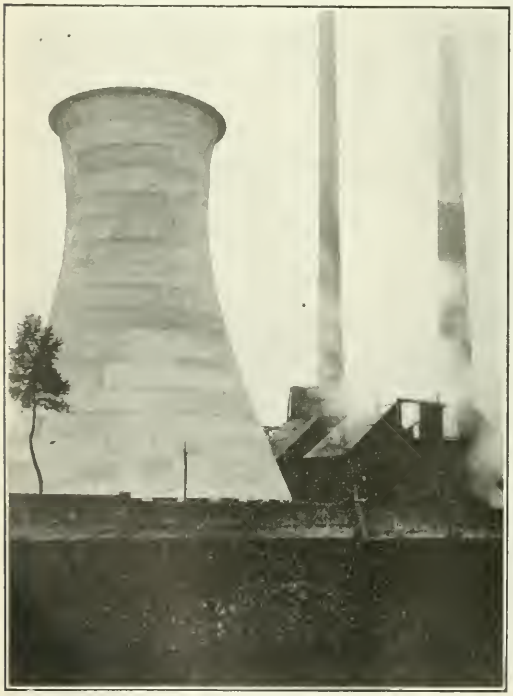


Fig 3—A Comparison of a Concrete and Wooden Cooling Tower.

As wooden cooling towers have a lifetime of only 15 years (*see* Fig. 3), and even in this space of time require many repairs, and as the initial costs and the expenditure on the upkeep of steel towers are prohibitive, the only material appropriate for cooling towers is reinforced concrete. The cooling towers represented in the illustrations are constructed on the principle of an eggshell. Instead of supporting the dead weight and providing for resistance against the pressure of the wind by means of separate supports on the outside or the inside of the walls, or by beams, buttresses or other reinforcements, the wall is of double curvature, which withstands the pressure of the wind and supports the deadweight by itself.* The reinforcing rods are placed according to the straight describing lines of the hyperboloid, and therefore require no bending. The construction although built with a minimum of material is of unexpected rigidity and strength, and therefore hardly more expensive than a wooden tower of about the same principal dimensions.

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* See for the calculation of the stresses "Engineering," 1919, p. 640, "Stresses in thin shells of circular section" (British patent 108,863).

Broadbent Motors.

An interesting series of motors both of the alternating and continuous-current types are made by Messrs. T. W. Broadbent, Ltd., of Huddersfield. Long experience and constant attention to detail has enabled the methods of manufacture and the various parts of the finished article to be satisfactorily standardised with the result that the motors now turned out have reached a high state of perfection. This is not to say that there has been any resting on past successes, for all the time continual attention is paid to possible improvements.

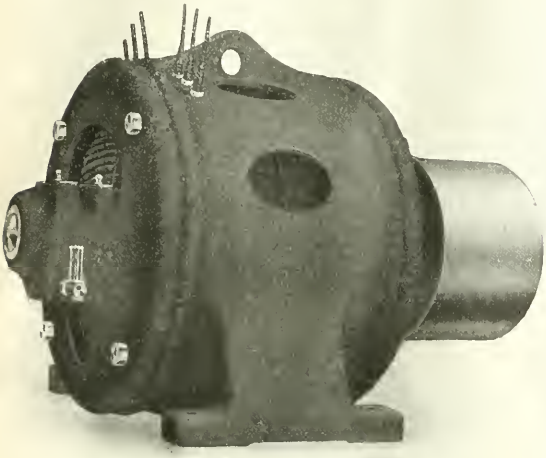

Fig. 1.—A Broadbent A.C. Motor.

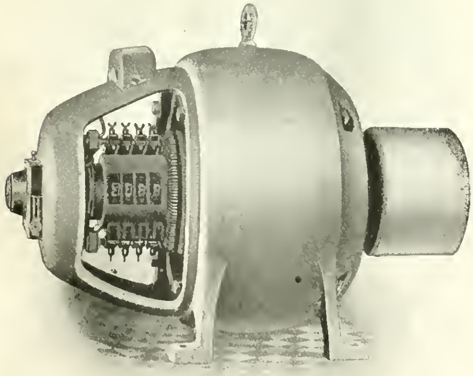

Fig. 2.—Typical D.C. Motor.

Of the alternating-current motors made by Messrs. Broadbent, the N type squirrel-cage motor is, perhaps, the best known. This motor is as good in point of efficiency and power factor as it is possible—with the present knowledge available—to make it. It is former wound throughout the whole range of sizes, and the rotor connections are made on the principle of the tramway rail bond, a method of rotor connections which was introduced by the firm ten or more years ago. This arrangement has proved eminently satisfactory in actual service. Owing to the fact that the rotor short-circuiting rings have every hole drilled before being fitted on the rods, any defects or blow holes in the castings are readily seen and any defective castings can, therefore, be rejected. It will readily be seen that this method offers advantages over the more common method of casting the short-circuiting rings on to the ends of the rotor rods, in which case it is practically impossible to detect possible flaws or defects in the castings. The method employed, it is claimed, ensures a perfect connection for every rotor rod. This feature, in conjunction with former winding and the exceptionally robust and heavy mechanical design, make, it is claimed, the N type motor one of the strongest and most robust motors on the market.

The R type motor is a "slip-ring" motor made for a range of larger sizes than the N type motor. This motor also is of very robust construction, fitted with neat, effective and reliable brush lifting and short-circuiting gear. Former winding is used throughout, and the slip rings are carried inside the end shield, so that there are no leads passing through the shaft to cause trouble, and the maximum strength of the shaft is retained.

The D type continuous-current generator has been on the market for so many years that it hardly needs mentioning. Besides the general compactness and convenience of the design, the details are all carefully thought out and accurately made. The G type continuous-current generator is a range of machines having outputs ranging from 100 kw. to 500 kw., and they are intended primarily for direct coupling. Here, again, compactness of design and convenience of operation have received careful consideration, and the result is a machine that will compare favourably in point of efficiency, cool running and sparklessness, as well as in its general appearance and contour, with any on the market. The M type continuous-current motor is designed on the similar electrical lines to the D type generator. The motor is of liberal proportions and is used extensively in the textile mills of Yorkshire, as well as in other parts of the country.

A Well-Known West Riding Firm.

Among the old-established engineering firms of repute, not only in the West Riding, but throughout the world, honourable mention may be made of Messrs. Cole, Marchent & Morley, Ltd. This concern has been established at Bradford since 1848, and for many years specialised in the manufacture of compound and triple expansion steam engines of both the horizontal and vertical type, of central exhaust steam engines and horizontal type medium-speed steam engines, of constant pressure crude oil engines working on the Diesel cycle, of vertical slow-speed gas engines and of gas producer and condensing plants, as well as winding and haulage engines, and Spencer-Dawson patent tramway brakes. Examples of this equipment are to be found running efficiently and satisfactorily throughout the country and among other places in the Valley-road station at Bradford.

Some notes on the details of the Diesel engine which the firm began to manufacture some six years ago may, however, be of interest. Designs and practice were purchased by Cole, Marchent & Morley from a well-known firm who had manufactured Diesel engines for some years, and as soon as possible they installed an engine at their works so as to be able to see and remedy any defects that might become evident. Since this date a number of engines have been supplied to the British Admiralty, and for general use in the British Isles and abroad.

The engines are built up with standard vertical cylinders of 50, 75, 100 and 125 B.H.P. each, in such a way that one, two, three or four units are erected on one bedplate, making a range of powers from 50 to 500 B.H.P in one set. The cylinders are supported by standard "A" frames which are bolted to the bedplate, and the inlet, exhaust and fuel valves are placed on top of the cylinder heads. The cylinders are of an improved design, and special hard, close-grained cast-iron liners are introduced in such a manner that the top only is fixed, the bottom being left free to expand in a vertical plane when changes of temperature take place in the cylinders.

The valves in the cylinder head are especially accessible. This is made possible by the fact that the camshafts are situated below the cylinders and run in enclosed boxes cast in the standards. These shafts run in ring-oiled bearings, and all cam discs, linkwork, rollers, pins, &c., run in oil baths arranged in the above gear boxes, which protect these important parts from wear and dust, tend towards noiseless running, and save a considerable amount of work in attendance and cleaning. The camshafts are driven from the engine crankshafts by machine-cut gearing running in oil baths.

All valves are arranged with their own independent casings in the cylinder covers, which, like the cylinders, have an efficient water-cooling system. They are operated from the camshaft by means of tappet rods, and all cam levers are fitted with hardened steel rollers and pins which engage in such a way that any lateral strain or tipping of the valves is prevented and tightness on their seats is assured. All valves can be removed in a very simple manner for cleaning, and replaced without disturbing the valve gear or pipe connections.

The lubricating system has received especial attention. Crankshaft bearings are ring-lubricated, with large supply reservoirs, and fitted with inspection holes which enable the level of the oil to be ascertained. Separate pumps force the lubricating oil into the cylinders, distributing it round the whole circumference of the cylinder walls, pistons, and to the gudgeon pins.

These engines have been designed to use any crude, residual, mineral oils, or coal tar oils, with the greatest economy, and with very high efficiency, even at light loads.

Mass Production of Small Motors.

The equipment of the small motor shops of the General Electric Company, Ltd., at Witton, has been arranged with the object of obtaining the maximum output, and at the same time the number of types and sizes of machines has been reduced to the minimum possible consistent with obtaining a range capable of every form of service at highest efficiency. For both the direct and alternating-current classes the range embraces motors from 1/50 H.P. to 5 H.P., and standard types of fans are made for both direct and alternating-current circuits as follows: 9½ in., 12 in., 16 in., 24 in., 36 in. and 56 in., and for both desk and ceiling use.

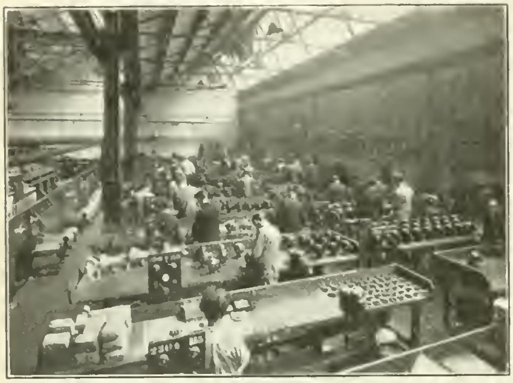

Fig. 1.—Fan and Small Motor Assembly.

One of the greatest factors which ensure the success of mass production methods is the provision of adequate store accommodation, and in this respect the G.E.C. are particularly well equipped; even in these days of shortage of material, large stocks of the various component parts are available. Part of the foundry is reserved for the production of the standardised frame castings, these being of special composition, chosen after lengthy experiment as the best possible as regards strength and permeability.

To ensure high-class repetition work in the machine shops a special system of jigs and gauges has been prepared, ensuring absolute interchangeability of parts in each type, while some of the same parts are often used in several types of machine. The most modern types of capstan lathes, grinders and milling machines are installed, and they are so grouped as to allow rapid transit in both directions through the shops—an essential factor in successful mass production. In this connection it should be mentioned that the various sections of the works are so located that the component parts travel progressively from the foundry to the test and despatch benches.

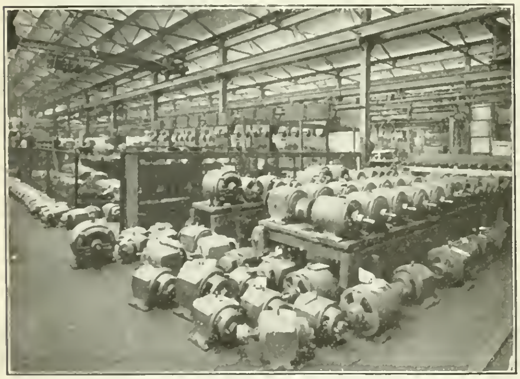

Fig. 2.—View in Despatch Department.

Parallel with the machine shop is the press shop where all classes of armature stampings are punched from high grade "Stalloy" or "Lohys" iron. In the winding shops, armatures, rotors, field magnet coils and stators are prepared. The operations are carried out in parallel lines of benches, female labour being almost entirely employed. Special benches and rotating stands are provided so that a very high winding speed for coils is obtained.

Each motor component part before going to the stores is enamelled, electro-plated, or given an oxydised copper finish as required, special methods being in use to effect a good finish. For assembly the necessary parts are all drawn from the stores in bulk so that the necessary groups of parts arrive simultaneously at the assembly benches and the machines can be built up in the most expeditious manner.

Parallel with the assembly benches runs the test bed, and each finished machine is conveyed to test within a very short time of its completion. From test the machines are conveyed to packing benches, and the outgoing store adjacent to the road is finally reached.

It is fairly general knowledge that the General Electric Company's works at Witton are being considerably extended. By no means the least important of these is an addition which will provide a completely new fan shop, while the present shop, where both fans and small motors are now made, will, with the addition of a further large bay, be used exclusively for small motors. When these extensions are complete, in both fan and small motor departments, it will be possible to develop the principle of mass production to an even greater extent, and the G.E.C. will be capable of supplying expeditiously the largest orders for the machines in question.

A New Wet-Air Filter

One of the latest and most ingenious types of wet air filter hails from Castleton, Lancashire. Its construction is very simple, and can be readily understood from the accompanying illustrations. Fine mesh expanded metal is used in either brass or galvanised steel; a series of revolving discs of this material dip into water, and the air is scrubbed as it passes through the upper portion of the machine. We have seen one or two of these plants working in connection with turbo-alternators with very successful results. The makers state that not a particle of solid matter can pass through their apparatus, and the condition of the outlet duct in a machine which has been constantly at work for nine months, in a very dirty atmosphere, fully bears out this very strong claim.

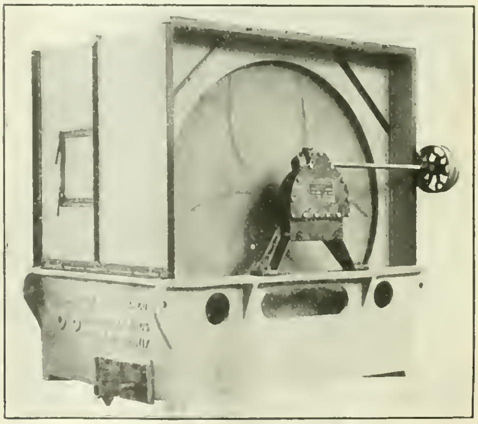

Fig. 1.—Front View of the Filter.

Fig. 1 shows the front view of the filter. One of the plants referred to above is working at one of the branches of the Fine Cotton Spinners' & Doublers' Association, Ltd., at Bolton, in conjunction with a Brush alternator rated at 535 kw. The actual load is constantly 700 kw., and yet, we understand, the alternator is functioning perfectly with no signs of overheating. This air filter replaced one of the dry type, and an extraordinary improvement was at once observed. The volume of air was practically doubled, and the temperature of the outlet air reduced by 50 F.—viz., from 170 F. to 120 F.

The water level in the lower casing is maintained by means of a ball cock connected to the town's main supply to make up the evaporation, which, however, is very slight, owing to the fact that the cooling surface is much less than that of other types of wet air filter, so that all the dust is extracted without an excessive addition to the humidity. It will be noted that neither pumps nor sprays (which are a considerable source of annoyance) are necessary with this apparatus.

Fig. 2 gives a general view of the main assembling shop, where the filters described above are manufactured, and serves to show that a very live and active business is growing up. Several other designs are now being developed, such as humidification for textile factories and water cooling for large condenser sets.

The makers of this expanded metal wet air filter are Messrs. Cleworth, Wheal & Company, whose works are fitted with very fine experimental equipment, so that they are able to carry out any tests that are necessary, both extracting soot, dust and smoke from the atmosphere, conditioning air for humidifying purposes and for cooling of water. The writer was privileged to witness a test for the extraction of soot and flue dust from the air. The water in the machine at the commencement of the test was perfectly clean, and after an hour's run some of the water being drawn off was perfectly black. So severe had been the test that in a tumbler full of water there was fully an inch of soot and dirt on the bottom of the glass after allowing the same to settle, while some of the lighter or finer portions of the dust was floating on the top of the water. Cotton wool pads were put at the air outlet of the filter, and there was no sign whatever of any dirt having come through. In addition to this the writer was given a test to show that, when the air is brought in direct contact with water, the moisture content of the air is not necessarily increased; this test was performed by heating up the air to about 85°F., and running water through the machine at a temperature of 60°F.

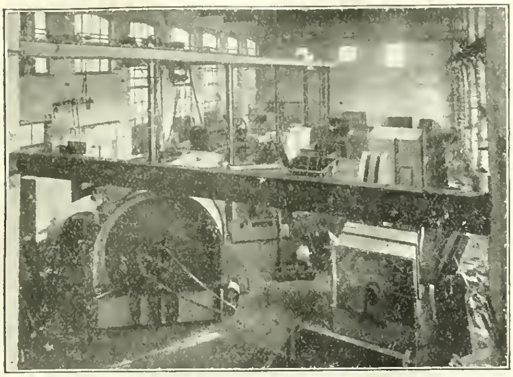

Fig. 2.—Assembling Shop.

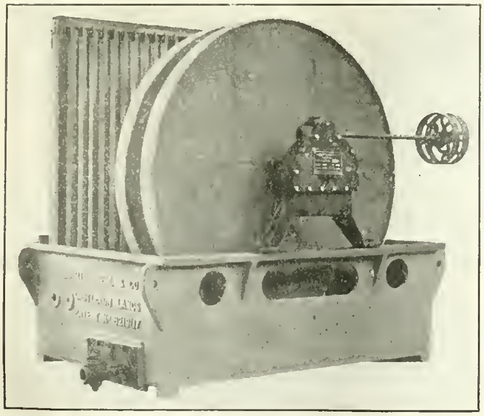

Fig. 3.—View of Filter with Top Cover Removed.

The efficiency of British Magnetos was amply demonstrated last week in the Tourist Trophy Races for motor cycles in the Isle of Man. Mr. T. C. de la Hay, winner of the senior event, using an All British "M-L" magneto, covered the course (226½ miles) at 51.79 miles per hour, the fastest on record. Mr. G. Dance, who made the fastest lap (37¾ miles) at 55·62 miles per hour (another best on record), and Mr. R. Brown, who was third, both used an "M-L." Another make of All-British magneto—the "T B"—was used by Mr. C. Williams, winner of the junior race, and also by the second and third men in the same event.

Gas and Electricity.*

Some of the electrical papers take exception to Sir Dugald Clerk and his thermal efficiency comparisons between gas and electrical energy. For our own part we never have agreed with these comparisons, and we are not likely ever to do so. The efficiency of electricity when used in a motor is about 90 per cent. The efficiency of gas in an engine is about 25 per cent. Thermally, a unit of electricity is equivalent to, say, 3,450 heat units. Used in a motor at 90 per cent. efficiency, 345 heat units are absorbed in the conversion of this electrical energy into 1·2 b.h.p.

In the case of gas, 3,450 heat units used in a gas engine at 25 per cent. efficiency, 2,590 heat units are absorbed in the conversion of this energy into 0·345 b.h.p.

1 unit of electricity or 3,450 units produce .... 1·2 b.h.p.
Or 3,450 heat units .... = 1·2 b.h.p.
12,000 heat units in gas .... = 1·2 b.h.p.

From a power point of view it is futile to attempt to compare electricity and gas on their thermal equivalents. Sir Dugald Clerk's definition of the efficiency of a gas making process as we deduce it from the figures he used in his joint report with Profs. Smithells and Cobb is as follows:—

$$\text{Efficiency} = \frac{\text{Heat units in gas}}{\text{Heat units in gas} + \text{heat units expended and lost in manufacture of gas}}.$$

Thus, referring to the cable giving the details of heat distribution in the Gas Light & Coke Company's process, we have in gas produced 26·7 per cent. of the B.Th.U.'s of the coal. The heat used and lost in manufacture is 29·1 per cent. He therefore gives the efficiency as

$$\frac{26{\cdot}7}{26{\cdot}7+29{\cdot}1} \times 100 = 47{\cdot}8 \text{ per cent.}$$

With such an arbitrary formula as the above, credit is taken for all the heat units remaining in the coke which is not gasified, as well as in other bye-products. In other words, credit is taken in a process of partial gasification of coal for a greater efficiency than a total gasification process would give. The coke remaining over is given a 100 per cent. efficiency; that is the effect of the formula used, because the coke has to be reckoned at 100 per cent. efficiency to arrive at the heat units used and lost.

We consider that electricians would be just as entitled to claim an efficiency in the generation and distribution of 53·8 per cent., this being the figure arrived at by taking a ton of coal and the heat units contained in it, and calculating the efficiency when only 10 cwt. had been gasified, giving themselves credit for the balance at 100 per cent. Thus, assuming ½ weight coal consumed, and ½ left raw with full calorific value, untapped

½ is transformed at 7·6 per cent. then ½ × 7·6 = 3·8
½ unused ....at 100 ,, ½ × 100 = 50·0
53·8

Then the average overall thermal efficiency of this so-called process becomes 53·8. To compare the gas making process with this, it would work out something like 70 per cent. efficiency, as against 53 per cent., which is a totally different thing from 45 per cent. for gas and 7·6 per cent. for electricity.

Gas sold	22·5 per cent.	
Coke sold	48·25 per cent.	70·75 per cent.
Tar sold	6·05	
Heat used and lost	23·2	
	100	

Efficiency on basis used for electric undertaking

$$= \frac{70{\cdot}75}{100} = 70{\cdot}75 \text{ per cent.}$$

Roughly, 1 ton of coal converted into electricity and gas on two of the many different systems would result as follows:—

Coal Converted into Electric Current.

1 ton of coal = say 30,000,000 B.Th.U.'s. Converted in electricity, 1 ton of coal = 1,000 units = 3,450,000 B.Th.U.'s.

The efficiency of this process would be 11·5 per cent., approximately 1,000 units of electricity in a motor at 90 per cent. = 1,200 b.h.p.

Ordinary Gas-making Process.

1 ton of coal = 30,000,000 B.Th.U.'s.

Heat units in gas ordinary process 6,000,000 B.Th.U.'s; Gas-making efficiency of this process would be, say, 20 per cent.

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* From "Gas," June 16.

6,000,000 heat units in a gas engine produce

$$\frac{6,000,000}{10,000}=600 \text{ B.H.P.}$$

Remaining from ton of coal: 10 cwt. coke, 10 gallons tar, 30 gallons ammoniacal liquor.

Complete Gasification Process.

1 ton of coal = 30,000,000 B.Th.U.'s.
Heat units in gas, 23,000,000 B.Th.U.'s.

$$\text{Efficiency } \frac{23}{30}\times 100=77 \text{ per cent.}$$

$$\text{B.H.P. equivalent of } 23,000,000 \text{ B.Th.U.'s}=\frac{23,000,000}{10,000}=2,300 \text{ B.H.P.}$$

On no general grounds that we can see can it be stated that any gas-making process compares as 45 per cent. efficiency for gas, as against 7·6 per cent. for electricity. The nearest approach is, of course, that of complete gasification, and in this case it has to be remembered that 3,450,000 B.Th.U.'s in electricity for heating a room would be used at 100 per cent. efficiency, whereas the 23,000,000 heat units in gas used for heating a room would not give more than, say, 50 per cent. efficiency.

For cooking, the comparison between electricity and gas is that of the heat equivalent of the unit of electricity—viz., 3,450 B.Th.U.'s, only about 30 per cent. is used, as compared with 30 per cent. to 40 per cent. with gas in ordinary cooking appliances, and 60 per cent. in the very latest appliances.

We believe it was Sir Dugald Clerk himself who once said that the more the truth about gas was realised the better it was for gas. We endorse the sentiment, and should like to see it put into practice. We have always been given to understand that Sir Dugald Clerk knows a good deal about the gas engine, and if he had taken the opportunity during his year of office as President of the Institution of Gas Engineers to show electricians how gas engines can with advantage be brought into use for the generation of electricity more cheaply and reliably than with mixed turbine or other steam generating sets, he would have earned rightly the gratitude of the gas industry and his country. If electricians have the facts demonstrated to them that the gas engine is the power to adopt, they will adopt it. Figures, necessarily fantastic, of thermal efficiencies cut no ice with any practical man, but they do bring the industry associated with their publication into grave disrepute. Drop thermal efficiency talk and give working results.

English Electric Company's Phoenix Works.

These works were established 20 years ago by the Phœnix Dynamo Mfg. Company, Ltd., for the manufacture of electric motors and dynamos of a limited range of sizes and types. On the manufacturing side attention has been concentrated on the continuous improvement of design and organisation of construction in series and quantities. In the first instance it was natural that the business of the company should develop in relation to local industrial requirements, and particular study was given to the special conditions pertaining to Yorkshire coal-mining and the woollen industry. The Phœnix Company was successful in developing a rapidly enlarging business with these two great local industries, in both of which there has been such remarkable expansion during the past 20 years. But the high technical reputation achieved by the company and the efficiency of its methods of manufacture enabled it gradually to extend its operations, and considerable business was done in other parts of the country and abroad; while larger sizes of machinery were, in more recent years, frequently manufactured for public authorities and for industrial installations.

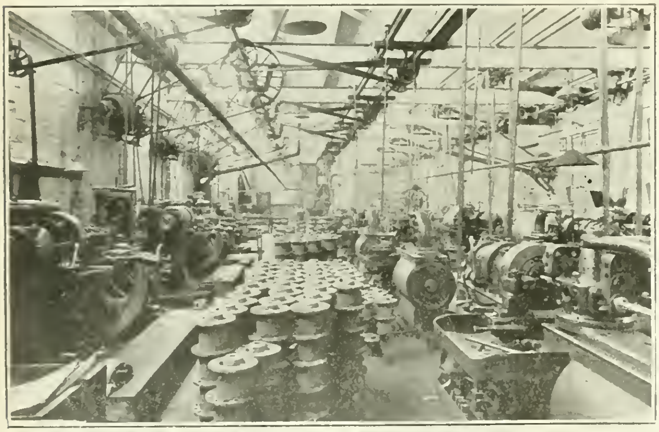


Fig. 1.—Automatic Machine Department.

When it was decided to consolidate under the title of the English Electric Company, Ltd., the several works now owned by that company, the acquisition of the Phœnix's Company's business was a very valuable part of the whole scheme. The purpose of the consolidation was on the one hand to obtain the benefit of more comprehensive sales organisation throughout the world; and, on the other hand, to take full advantage of the policy of specialist production in the several factories. The Phœnix Works have thus been applied to the most efficient methods of manufacture of certain sizes and types, and production of larger electrical machinery has been allotted to other works of the English Electric Company. The policy in regard to the Phœnix Works is standardised production of quantities of electrical machines of certain sizes and types by such methods as to combine the lowest cost with thorough soundness and efficiency.

The term "mass production" is not properly applicable to this work, as, while every advantage is taken of possible means of conveniently handling quantities of standard parts, the machine finally produced is in every respect a sound engineering job, undergoing the usual tests and complying with the most rigid specification requirements.

The Phœnix Works cover a large area, with ample room for future expansion, and at present employ 1,200 people. The great value of the local connection is continuously experienced; but, through the organisation of the English Electric Company, the products of the Phœnix Works are steadily increasing in general reputation and demand.

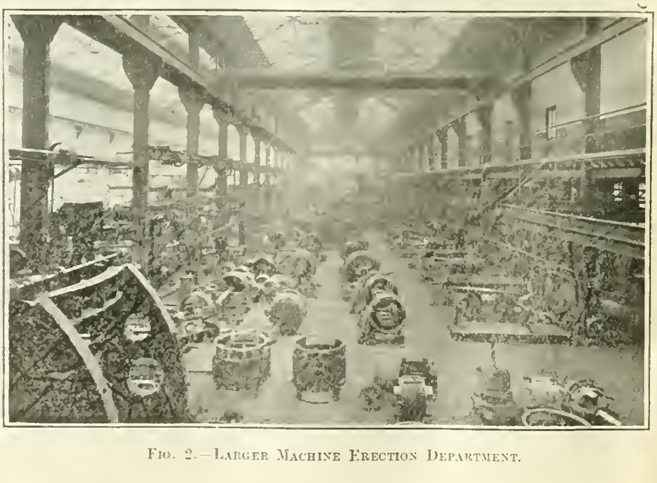


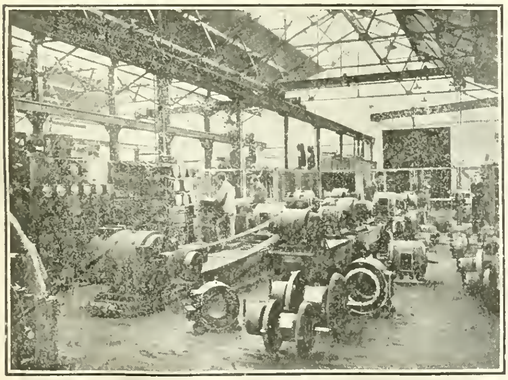
Fig. 2.—Larger Machine Erection Department.

Organised A.C. Motor Manufacture.

Electrical engineers travelling from Ilkley to Bradford or Leeds will see at the side of the line at Guiseley a modern looking factory which belongs to Messrs. F. & A. Parkinson, Ltd. In these works is carried out the organised production of single-phase repulsion motors and polyphase induction motors. The firm was established in 1912 for the purpose of manufacturing single-phase repulsion motors under Creedy's patents. Early in 1914 they began the manufacture of polyphase motors with outputs up to 10 H.P. with such successful results that at the beginning of 1918 they found it necessary to erect new shops at Guiseley on a site of 18 acres. These opened immediately after the Armistice for the manufacture of two- and three-phase induction motors of standard pattern, and of both the squirrel cage and slip-ring types with outputs up to 75 H.P. In spite of the fact that these works have been opened for so short a time they are already being extended and ultimately will occupy an area approximately equal to three times that of the original site.

View of a Shop.

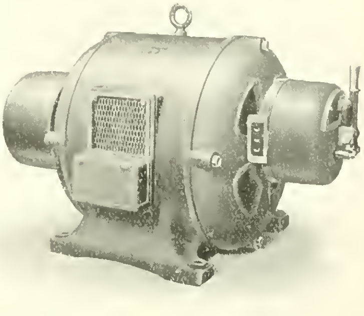
The accompanying illustrations show views in the works from which it will be seen that the lay-out is modern, and it is, therefore, not surprising to learn that great attention has been paid to the organisation of production methods with such success that the works have now an output capacity of 5,000 machines per annum. An interesting point is that there is no shafting in the works, all the machines being driven direct by Parkinson motors.



View of another Shop.

The necessary supply of energy for this purpose is derived from a 250-H.P. gas engine which drives both a direct-current generator and an alternator. There are also two motor generator sets which can work in both directions to provide the necessary current of any kind for testing purposes. The test bed is very complete and compact, and to electrical engineers is, perhaps, the most interesting part of the works. A test board with a bewildering arrangement of plug connections is installed so that different phase and voltage connections can be provided as desired.

Turning to the products of these works we may call attention to the illustration which shows a standard Parkinson induction motor. The design is neat and artistic and complies with all the best rules of architecture. These motors are made in four types protected, enclosed, ventilated, totally enclosed and pipe ventilation or drip proof. In the first of these ventilation is obtained through openings in the end brackets of the stator case, baffle plates being fitted to direct the current of air. The air enters at the ends and out at the middle. The efficiency of this arrangement is obvious when it is pointed out that a machine of this type rated at 32 H.P. has only a safe output of 11 H.P., when it is totally enclosed In the enclosed ventilated type the openings are suitably protected by expanded metal grids, while in the totally enclosed type stator case and end brackets are cast solid without any ventilation holes. Connections from both ends of all the phases are brought out to a protected terminal board on the machine and a special device is fitted which prevents undue twisting of the wires when connections are being made or unmade. The stator frame and feet are all in one piece, the frame being bored internally to receive the stator core and machined at both ends to take the bearing brackets.



Standard Parkinson Induction Motor.

Those who are interested in details of construction in electric motors and wish to see how enterprise can be successfully applied to the turning out of a motor of the highest quality are advised to "step off" at Guiseley and see what is being done in Messrs. Parkinson's works. In these days of industrial disputes, it is also well to note that the relations between the directors of the company and their employees are of the most cordial character. Welfare work has reached a high stage of development, and the company has provided good recreation rooms, playing fields, &c.

Correspondence.

HEAVISIDE'S WORK.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In looking over a Paper by Dr. T. J. I'A. Bromwich in the "Philosophical Magazine" for April, 1919, I find that a formula (2), page 408, dealing with Oliver Heaviside's operational methods, is given as new. It seems to me that the formula in question is but a special case of a more general formula given by myself in the French "La Revue Générale d'Electricité," pp. 691–693, of November 9, 1918, and abstracted in "Science Abstracts" "A" in the issue of February 28, 1919.

With regard to the footnote, p. 418 (*l.c.*), it is to be observed that the integrational series developments do not always result in the same functions obtained by the Heaviside differential series developments. This is very important. Thus, solutionally, both types of functions should be expressed *formally*. The subsequent treatment is then analagous to that in which equal roots (solutional forms) occur in algebraic equations.

Finally, kindly allow me to express my deep gratification in the work of Dr. Bromwich in bringing to the attention of pure mathematicians the wonderful power of Heaviside's operational methods. It has been a very difficult thing to obtain a hearing, so much so that things have had to be put away "for better or for worse."—I am, &c.,

East Pittsburg, Pa., U.S.A., A. Press.
June 4, 1920.

The National Physical Laboratory.

The annual inspection of the National Physical Laboratory was held last Tuesday, when a large number of visitors were received by the President of the Royal Society as chairman of the General Board.

It may be said that the laboratories have now resumed their pre-war appearance. There are no longer portions which must be kept from the public gaze, and the visitor may ramble around according to his inclinations. But there is a marked change since those pre-war functions, when the reception seemed unduly crowded. In these days the buildings have been so increased that a large number of visitors is scarcely noticeable. From the point of view of giving any account of what is to be seen the greater area presents a disadvantage. To start with, there is the dual attraction, namely, interesting things *versus* interesting people: for many interesting people foregather on this occasion, and even if these were wholly disregarded it would be impossible to make a thorough inspection in a couple of hours or so. For this reason we venture to suggest that the Board might advantageously give the technical Press the privilege of a private view a day or two before the official inspection.

For the electrical engineer, perhaps, the research on the heating of underground cables, which has been in progress for some years, was the most interesting exhibit. The cables are tested in 100-ft. lengths, with three types of laying, namely: (1) laid direct in the ground, (2) in ducts, of which there are a group of six, and (3) laid solid in bitumen. At the present time, the cable laid direct in the ground is a large one, being 3-core, split conductor, for 20,000 volts, the nominal area per phase being 0·2 sq. in. Among the interesting points brought out is the fact that the variation in thermal conductivity of the dielectric in paper insulated cables may be very considerable, as between one make and another. This is important, as the permissible load depends, of course, upon the rate of cooling. Another factor is the moisture content in the soil. Measurements on this point are being taken in various parts of the country, and the rating will probably depend upon the lowest figure for moisture that may be expected, this giving the highest temperature rise. In the ducts the cables are being varied for all the combinations that are met in practice. At one time alternating current (about 400 amperes) was used for heating the cables and continuous current (20 amperes) was superimposed when desired for the purpose of measurement. This arrangement was found to be quite satisfactory.

At present continuous current is being used for these tests, and is supplied by a motor generator giving 5,000 amperes at 6 volts. The method of automatically regulating this current is of interest. The current passes through a shunt, the P.D. of which is balanced on a potentiometer. In one of the connections to the potentiometer is a galvanometer, so that if the current is above the normal the deflection is in one direction, and if below it is in the other direction. At either end of the galvanometer scale is a selenium cell. These cells form two arms of a wheatstone bridge, and from their junction across the bridge is connected a polarised relay. Thus, when one of the cells is illuminated the balance is upset and the relay deflects to one side or the other. This actuates other relays which serve to cut resistance into or out of the shunt circuit of the machine. The arrangement, as it depends on the potentiometer principle, is very sensitive and responds readily to one-tenth of one per cent. The relays were continually at work.

We were interested to see some samples of manganin, made at the laboratory, which had been drawn into wire and appeared to be giving very satisfactory results.

In the photometry department a series of tests were in progress on the candle power given by miners' lamps in various directions, taking into account the obstructions due to the construction of the lamp.

In the wireless department a number of interesting methods were on view, including the measurement of amplification, as described recently by Mr. F. E. Smith before the Physical Society. Also a method due to Mr. Smith, of measuring the efficiency of valves by observing the temperature of the anode by an optical pyrometer. The temperatures are first taken when a steady plate voltage is applied, and when all the energy is then being wasted. Having obtained the relation for various temperatures, the temperature is then observed when the valve is oscillating.

One of the chief attractions was certainly the large wind terminals. We remember the time when such a terminal, about 3 ft. square, was exhibited with pride. Now there are terminals 7 ft. square, and the newest is 7 ft. × 14 ft., and requires a large building to itself. The various methods employed for measuring air velocity and stresses or oscillations experienced by the models are most interesting, but lack of space prevents our going further into this development.

Wireless for the Army.

According to "The Times," it is intended to equip the Army with wireless apparatus on a far wider and more general scale than hitherto. This decision is the outcome of the successful experiments made at the Woolwich establishment in connection with the use of radio-telegraphy for the Air Service in direction finding and in high-speed telegraphy. Our contemporary gives a description of some of the instruments used in the experiments, and of the results achieved. Some of the instruments used at Woolwich are said to have transmitted messages at the rate of over 1,000 words a minute. A new miniature revolving type of direction finder is said to have a range of 250 miles, and to be accurate to one degree. Experiments have also been carried out in the transformation of ordinary ground-line telegraphy into wireless. This instrument provides for a normal speed of 450 words per minute, with possible demonstration speeds of 1,000 words per minute. Continuous oscillations are employed, and interference with other wireless receiving sets is said to be reduced to a minimum. Owing to the extraordinary selective receiving and recording apparatus employed, interference from other transmitting stations and atmospheric disturbances are also greatly reduced. The actual transmitting and recording parts are of the standard P.O. Wheatstone type. Although normally rated at 400 words per minute, by means of a new double current relay, the speed of the inker has been raised to 450 words per minute. The sets can be operated by remote control over any convenient distance, and the normal working speed is at least three times that of any other existing system. Owing to the extremely small current at the transmitter contacts, very high speeds are possible, the speed of transmission being governed only by the permissible maximum working speed of the Wheatstone.

A simpler form of instrument for higher speeds consists of a motor driven spur wheel drawing slip, punched on the Poulsen system, between roller and contact makers. Messages have been transmitted by this instrument between Aldershot and Woolwich at 750 words per minute, recording being effected by electro-chemical means. In the valve transmitting sets, the generating valve is controlled by a smaller control valve in its grid circuit, the control valve acting as a grid leak. The controlling valve is operated by means of a Wheatstone automatic transmitter. An experimental receiving set with P.O. standard inker has also given satisfactory results between Woolwich and Aldershot at 450 words per minute. In regard to transmission, no difficulty is anticipated in controlling the largest power valve sets at 450 words per minute by ordinary P.O. apparatus. The receivers will be practically immune from interference, except from stations operating on the same wave-length. The chemical inker used consists of specially prepared paper drawn between a roller and a marking pointer, the pointer and roller maintaining continuous contact with the paper. The arrival of a signal causes a current to pass through the paper, producing discolouration, the signal being recorded in the same form as with a Wheatstone recorder. It is further stated that the amplifier which has been used enables the operator to listen to a sending station hundreds of miles away, undisturbed by the working of another wireless set in the room where he is employed.

Municipal Tramways Association.

The annual meeting of the Managers' Section of the Municipal Tramways Association was held at Birmingham on the 16th and 17th inst. Mr. G. W. Holford, vice-president, occupied the chair on the opening day, but before the conference Mr. W. E. Lee, chairman of the Birmingham Tramways Committee, gave a reception and the members were entertained to luncheon by the Lord Mayor (Ald. W. A. Cadbury). The report of the sub-committee on the "Standardisation of Overhead Line Material" was submitted by Mr. L. E. Harvey (Ilford). It was suggested that, if tramway undertakings would adopt certain standard sizes of trolley wire, and a certain shape in grooved wire, they would reap the advantage of quick delivery and lower costs of fittings and wire; and the committee decided on standards which were generally acceptable.

In a Paper on "The Possibilities of Railless Electric Traction," Mr. R. H. Wilkinson (Bradford) stated that up to the present railless vehicles had been considered as an auxiliary or adjunct to the main tramway service; but under present conditions the possibilities of a considerable extension of railless electric traction transportation appeared very probable. He had been favourably impressed with the performance of those vehicles, and could see a much brighter future in store for them. They had been in operation in this country for nine years. Attempts to improve their design had been hampered by the weight restriction imposed—5 tons loaded—and the uncertainty of the amounts they were called upon to contribute for road maintenance. The weight restriction resulted in the vehicles being made of materials much too light to withstand the wear and tear of service, with the inevitable result—increased working expenses and frequent breakdowns. The Ministry of Transport a few months ago altered the weight restriction from 5 tons loaded to 5 tons unloaded, so that a more economical and reliable vehicle could now be made. In Bradford the working costs were higher than they would be with properly constructed vehicles; but, nevertheless, were approximately 4d. per mile less than those of the tramcar. Railless cars were not as comfortable to ride in as tramcars, providing the tramway permanent way was kept in good condition. They were liable to skid on snow, and, not having a defined track, were more likely to collide with other vehicles in foggy weather. The present vehicles were not so reliable as tramcars, but they could be made so. On the other-hand, they possessed certain advantages over tramcars. A vehicle breaking down did not interfere with, or cause any delay to, the other vehicles in service; they could draw closer to the side walk for loading and unloading; they made considerably less noise than a tramcar and offered greater facilities for inter-running. Railless vehicles would be likely to prove of considerable benefit in the carriage of parcels and goods.

On Thursday Mr. H. Mozley, general manager of Burnley, read a Paper on "Brakes"; and Mr. J. R. Groves, of Barrow, dealt with "Overhead Pole Construction and the Best Method of Strengthening Poles Corroded under the Collar." Mr. E. S. Rayner, general manager of Hull tramways, introduced the question of "The Unions that Should be Officially Recognised by Tramway Undertakings as Dealing with their Particular Classes of Employees," and also he referred to the possibility of arranging for a committee of employers to confer with a committee of the unions of the various trades to settle the question of the demarcation of work, and to prevent squabbles between the members of the various unions as to which trade any particular job belonged. After discussion these questions were referred to the Executive Council.

Developments in Miners' Lamps.

At the London meeting of the Institution of Mining Engineers last week several interesting developments in miners' lamps were discussed.

Mr. W. Maurice referred to the Fleissner Singing-Flame lamp, which has interesting features, but is still in the experimental stage. The most satisfactory means of detecting the presence of firedamp is still the safety-lamp, which depends upon recognition of the explosive limit. A sufficiently hot flame in the presence of a small quantity of methane produces a "cap" or "halo." However, this is in practice difficult to recognise with precision when the percentage of gas is low. An alternative method is the production of a singing flame, thus giving an audible instead of a visible indication. This effect occurs when a vertical tube, open at both ends, within which a flame is burning, produces powerful resonance of the tube. The theory is obscure, but the conditions under which singing occurs have been studied closely. The author presented diagrams showing the nature of the apparatus, and exhibited specimen lamps. The flame is first so adjusted that in normal air it will not sing, or only very slightly, but as soon as inflammable gas is introduced into the apparatus an increase in the intensity of the flame occurs, and the sound is accentuated. The apparatus can be rendered very sensitive, but the phenomenon is produced more easily with an acetylene flame than with benzine, which must be burned in a Bunsen burner.

Mr. Maurice subsequently gave a brief description of the Wolf-Pokorny and Wiede acetylene safety lamps. At present such lamps would not be accepted by the Mines Department in this country, but the conditions of safety, the author suggests, need reconsideration. Accidents due to causes other than the presence of firedamp now predominate. The most essential thing for the miner is to get more light. The two lamps were described in detail. An interesting question is the use of internal igniters. One form uses a paraffined linen ribbon, on which spots of phosphorus paste are deposited. These "match-heads" are struck and ignited by a ring handle. An alternative form of igniter uses cerium alloy, which gives sparks when struck by a rough surface; this method appears somewhat less safe, though, like the other type, it has been used by six nations for ten years or more. The Wolf-Pokorny lamp is in regular use in various countries, the Wiede lamp has so far only been used in mines controlled by the inventor. In both cases steps are taken to render these "safety lamps," and they appear to have special advantages for rescue work, as an acetylene flame will burn brightly with less oxygen than any other illuminant.

The "Oldham" lamp, described by Mr. George Oldham, is a cap-type of miner's electric safety lamp, devised specially for use by trammers, rescue parties and in cases where the user of the lamp should have both hands at liberty. The accumulator outfit is carried on the back, the electric lamp mounted in the cap, which is of special design. Connection is made by rubber-covered cab-tyre cable, protected by flexible brass tubing, fitting into sockets in ebonite insulating blocks, lead-plug rivet locks being provided both on the cap and the accumulator-case. The accumulator is of the "Oldham" type designed to avoid any possibility of leakage of acid; solidified acid can be used, but free acid is considered preferable. The cell gives 2 volts, with a capacity of 5 ampere-hours. The weight of the cap-lamp fitting with 6 in. of cable is 6 oz.; the weight of the entire outfit 3 lb. 3 oz. The lamp takes 0·5 ampere at 2 volts, and gives an equivalent of 1·6 c.p., with a beam extending over an area of 10 sq. ft. at a distance of 2½ ft. A special design of flange-tight switch is fitted to the accumulator case.

Electricity Undertakings' Charges.

In a recent issue we referred to the deputation from the Home Counties (No. 9 area) Joint Industrial Council for the Electricity Supply Industry which waited upon the Electricity Commissioners in order to make representations as to the necessity for increased charges for electricity supply, &c. We are pleased to note that the efforts of the Industrial Council have been partially successful, and that a change of procedure has been decided upon, as will be seen from the following reply:—

The Minister has decided that companies seeking an increase in their maximum rates of charge may now make application to him under sec. 32 of the Electric Lighting (Clauses) Act, 1899, instead of under the Statutory Undertakings (Temporary Increase of Charges) Act, 1918. This will enable all companies, with very few exceptions, to make application should that course be necessary. The few exceptions are those companies whose Orders were granted to local authorities prior to the passing of the 1899 Clauses Act, and subsequently transferred to companies.

Such companies and local authorities to whom Sec. 32 of the Act of 1899 does not apply, may make application under the Statutory Undertakings (Temporary Increase of Charges) Act, 1918. The Commissioners will conduct any inquiries that may be necessary, and they will be always willing to hear any representations which the Industrial Council for the district may desire to make, and the Industrial Council will be notified when any application for an increase of charges is made.

With regard to the second point raised by the deputation, the Ministry has no power to allocate to any particular purpose any part of the sum produced by the sanctioned increase of maximum charge, but representatives of the Industrial Council can attend any inquiry and be heard thereat.

As regards the third point raised by the deputation, the Minister is advised that he cannot restrict the grant of an increase only to undertakers who agree to carry out the recommendations of the Industrial Council.

Legal Intelligence.

Workmen's Compensation.

At Sunderland County Court last week Judge Moore awarded £150 to Mr. Robert L. Black as compensation for the death of his son (Robert A. Black, aged 16 years), against Messrs. Wm. Gray & Company, of the Wear Shipyard. On Dec. 16 last the youth was repairing an electric wire on a ship when some unknown person turned on the current and he was killed instantaneously.

Is Electric Lighting Decoration?

On the 18th inst., Sir Francis Newbolt, Official Referee, gave judgment in an action by a builder to recover £89, balance of account of £609, in which was raised an interesting point of law under the special war legislation as to whether an electric installation for lighting purposes could be regarded as coming within the term "decoration" laid down by the building licensing order of the Ministry of Munitions. Plaintiffs were Messrs. John Cuddon & Company, and defendant was Mr. Hy. T. Robinson, who set up the defence that the contract being for more than £500, the sanction of the Ministry of Munitions became necessary, and that, such sanction not having been obtained, the debt was irrecoverable. Plaintiff's case in answer to this was that the work was done under orders given from time to time, and that, after deducting the cost of the electric lighting, the amount did not reach £500.

Mr. Henrique, representing plaintiffs, argued that the electric lighting was not decoration, and therefore did not come within the regulation of 1916, which provided that a license must be obtained for works of "construction, demolition or decoration" exceeding £500. The electric lighting was carried out by Mr. Seagrave, an electrical engineer, and defendant said that when the estimate was given to him he understood it was to include the electric lighting.

The Official Referee found that the defence of illegality had not been made out. It was abundantly clear that when the contract was made it was thought by both parties to be a smaller job than it turned out, although even now, including the cost of electric lighting, it scarcely exceeded the limit of £500 named in the order of the Minister of Munitions. He was not convinced that the electrical installation, which amounted to £123 16s. 3d., was included in the words of the order—"construction, alteration, repairs, decoration or demolition," and it was clear to his mind that in this particular case the total cost of the whole completed work in contemplation in relation to repairs and decorations never exceeded £500. It was common ground that until the work was finished and the final account prepared neither party knew that a license was necessary. In deciding that plaintiffs were only entitled to the reduced amount of £21 5s. 3d. on their claim, Sir Francis said that, although defendant had succeeded in reducing the claim, the expenses had been increased by the defence of illegality, and therefore, in giving judgment for plaintiffs for £21 5s. 3d., he ordered defendant to pay plaintiff half of the taxed costs.

Commercial Topics.

A Dutch Electrical Exhibition.

It is announced that an electrical exhibition will be held by the Municipality of Leeuwarden from Aug. 14 to Sept. 15 next, and the British Vice-Consul thinks British firms should organise a British section, for which it is possible to allocate space. In view of the important developments in electricity supply which are about to take place in Holland, it certainly seems advisable that British manufacturers should participate.

* * * *

Callender's Progress.

The results of the past year's working of Callender's Cable & Construction Company are a good example of what British grit and enterprise can perform under difficult conditions. The reorganisation of the company's factories on a peace-time basis of production was successfully accomplished, and a new factory equipped for the manufacture of high-tension cables in order to be in a position to meet the demands which will arise from the development of electricity supply. In addition, the company's colonial and foreign connections were strengthened and extended, and an interesting scheme of running the factories on rotary shifts has been introduced. As was to be expected, complaint was made of the serious effect upon the industry of the Excess Profit Duty, and of the determination of the men's unions not to allow more than the fixed number of hours to be worked. In order to provide capital for further developments, the company is making an issue of 400,000 7½ per cent. "B" shares of £1 each at par, and of 1,000,000 £1 ordinary shares at 22s. each; and on these attractive terms of issue there should be no difficulty in securing the amount required.

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Canadian Electrical Supplies.

Mr. F. W. Field, H.M. Trade Commissioner at Toronto, reports that the Hydro-Electric Power Commission of Ontario has notified electrical manufacturers, dealers and contractors in Ontario that all electrical material, devices and fittings for use on inside electrical installations in the Province of Ontario, must not be offered for sale until their design and construction has been approved by the Hydro-Electric Power Commission of Ontario, in accordance with the terms of the 1916 Act (6 Geo. V., Cap. 19). Manufacturers, whose products are approved by other recognised authorities and which also meet the requirements of the Commission, may have same placed on the approval list by making application in the method laid down.

In the past a good deal of inferior material has been used in wiring work in various parts of Canada, and though there are no general regulations for the whole of the Dominion, the tendency is to adopt the rules of the American Electrical Code which ensure a fairly high standard of workmanship and the employment of good class fittings and materials. It is desirable that all inside work should be executed in a proper manner so as to avoid risk of fire and accidents, but we think that the method proposed by the Ontario Commission may lead to abuses, and it could certainly be employed as a clog upon progress.

The Department of Overseas Trade has received a telegram from H.M. Trade Commissioner at Toronto (Mr. F. W. Field), requesting, on behalf of an Ontario inquirer, quotations by telegrams with full information respecting delivery for standard sizes of conduits for electrical installations. Early delivery is an essential feature of the business. British firms interested should communicate by telegram with Mr. Field, whose cable address is "Toroncom," Toronto. The Trade Commissioner also asks for samples to be sent to him at 257-260, Federation Life Buildings, Toronto.

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Progress of Power Companies.

During the week the reports of two of the power companies were published and show very satisfactory progress, notwithstanding labour and other troubles. The Lancashire Power Construction Company, which owns the entire capital of the Lancashire Electric Power Company, is able to increase the ordinary dividend to 7 per cent. from 6 per cent. in 1918. The gross income is £41,500 and the net profit £24,300, compared with £34,700 and £17,100 in 1918-19; while the units generated rose from 49,581,900 to 50,671,536, and the horse-power connected from 35,000 to 39,000. Important extensions of the generating plant and mains are being made and it is hoped that the first of the two 10,000-kw. sets on order will be in operation in October next.

The South Wales Electrical Power Distribution Company has had a somewhat unfortunate and chequered career, but, judging by the past year's report, the outlook is now distinctly hopeful. For some time past the undertaking has been carried on by the Treforest Electrical Consumers Company, and this arrangement has enabled the prior lien debenture interest to be regularly paid, and since 1915 the interest on the 5 per cent. debenture stock also. A large sum of money is now required for developments and the Treforest Company is willing to find £400,000, subject to certain conditions. By an agreement the Treforest Company has undertaken to regulate the charges for current so as to provide a net revenue, after making provision for all prior claims and preference dividend, of a sum of not less than £3,000 a year which will be available for dividend on the ordinary capital. This sum will only give ½ per cent. on the ordinary shares, which have never had a dividend. The agreement, however, requires the consent of the debenture-holders. The Power Company, which is going to re-organise its capital, sold 45,127,985 units last year, an increase of 8,534,082 over 1918. There is an increasing demand for power for mines and factories, and also for a bulk supply.

Electricity Supply.

SUNDERLAND Corporation have acquired additional land in Farringtom Row for extensions of the electric supply works.

HASTINGS Town Council proposes to extend the supply mains to the new local housing sites which are being developed.

The PAISLEY Dean of Guild Court has authorised the Corporation to erect two electricity sub-stations.

It has been decided to adopt electric lighting at the EASTVILLE (Bristol) Poor Law Institution, at a cost of £2,085.

BARNET Guardians have decided to adopt electric lighting in the Wellhouse Hospital at an estimated cost of £3,370.

Application has been made by BATLEY Corporation for sanction to borrow £4,600 for new supply mains and services.

GREAT YARMOUTH is putting down an additional 2,000-kw. turbo-alternator in order to meet the increasing demand for electrical energy.

MEXBOROUGH Urban Council has decided to purchase a 1,000-kw. turbo-generator for £13,170, subject to the consent of the Electricity Commissioners.

NOTTINGHAM Corporation have purchased for £15,000 about 80 acres of land on the banks of the Trent above Clifton Colliery, to serve as a new power station.

The PORTRUSH (Co. Antrim) Urban Council has decided to expend £16,000 on electric supply works, and supply mains will be laid to the Dhu Varren suburb if the funds will permit.

A canvass for prospective consumers having proved highly satisfactory, the promoters of the CULLOMPTON (Devon) electric supply scheme have decided to go forward with the project.

The East Anglian Electricity, Ltd., has been granted permission by SUDBURY Corporation to erect poles and overhead wires in connection with its scheme of electricity supply for the district.

WIMBLEDON Corporation has obtained authority to borrow £15,000 for electric supply mains and services and £2,100 for sub-stations. It is also proposed to put in two additional boilers at the generating station.

ATHLONE Urban Council has instructed a committee to report upon two projected electric supply schemes, one estimated to cost £20,000 and the other £17,650.

The RAMSGATE & District Electricity Supply Company has increased its charges as follows: power, 7d. per unit for first 100 per quarter, 4½d. for the next 3,000, and 3½d. beyond; heating, 4½d. for the first 300 and 3½d. beyond.

Mr. J. M. M. Munro has been retained by LANARK Town Council to prepare an electric supply scheme, with approximate estimates of cost of steam-driven and hydro-electric plant. It is thought that it may be possible to utilise water-power from one of the falls of the Clyde.

We learn that the schedule of consolidated rates drawn up by the Home Counties (No. 9 Area) INDUSTRIAL COUNCIL for the Electricity Supply Industry has been approved by the National Council and circulated to the member-companies, the date from which the schedule become operative being May 1.

In order to put down additional generating plant at the electricity works, to extend the feeder system and to lay mains in the northern area, &c., WORKSOP Urban Council has applied for sanction to borrow £50,000. This decision has been come to after considering a scheme for taking electrical energy in bulk from the Manton Colliery.

NEWPORT (MON.) Corporation have decided to apply for sanction to borrow £208,616 for additional generating plant and mains extensions, including £67,530 for a turbo-alternator and condensing plant and switchgear; £51,557 for boiler-house plant and buildings; £61,655 for mains and services; £10,362 for rotary converter and switchgear.

LITTLEBOROUGH Urban Council has asked their consulting engineer (Mr. W. C. C. Hawtayne) to prepare plans and estimates for cables and fittings for the supply of electricity to the new houses which are being built by the Council, as well as for the street lighting in connection with the scheme.

BURY Electricity Committee will apply for sanction to borrow £95,000 for carrying out extensions for inter-connecting the Corporation and Lancashire Electric Power Company's undertaking at Radcliffe. Subject to the approval of the Electricity Commissioners, it is intended to place a contract for an 8,000 kw. to 10,000 kw. set.

At a conference of representatives of the interested local authorities, it has been agreed that the centres of the electricity supply areas into which the county of DEVON should be divided should be at Plymouth, Exeter, Barnstaple and Torquay. Parts of Somerset and Cornwall are included in these areas, and a scheme will be submitted to the Electricity Commissioners next week.

Negotiations are to be entered into by AYR Corporation for a supply of electricity in bulk from Kilmarnock Corporation. The Electricity Commissioners intimate that this is the best way to deal with the present situation. The negotiations are to be without prejudice to the possibility of the establishment of a Joint Electricity Authority for the district immediately surrounding Ayr and Kilmarnock.

EDINBURGH Corporation have referred back a minute approving the action of the engineer and manager of the electricity undertaking, who had dismissed a workman for absenting himself from work on May 1 without leave, as it was thought that dismissal was too severe a penalty. It appeared that the man did not ask leave to stay away, but told the oreman he was going away. The foreman had no authority to grant such permission, and he admitted to the station superintendent that he should have got his permission.

A dispute which recently arose at Derby, Nottingham and Leicester owing to the refusal of the Councils to pay the bonus of £30 in accordance with the recommendation of the National Joint Board of Employers and Staff (Electricity Supply Industry) has been settled. The members concerned, supported by the E.P.E.A., had intimated their intention of withdrawing their services on Friday last, if the Councils did not reconsider their decision. It is therefore satisfactory to know that the Corporations have since decided to pay the bonus to the technical staffs as from Jan. 1 last.

Southampton Electricity Committee is negotiating for the purchase of the power station at the Government rolling mills, Woolston, for £125,000. The Committee must expend about £150,000 on new plant in order to be able to meet all demands for electricity likely to be made in the winter of 1921-22, but if Woolston station be acquired additional plant will not be required. In addition, the Committee is pledged to provide electricity for the Woolston district, and as the rolling mills would become a large manufactory, it is expected that other developments will take place in the district.

The Ministry of Health has issued its award on the applications of the boroughs of Sheffield, Rotherham and Barnsley for the extension of their boundaries. To the city of Sheffield, part of the urban district of Handsworth, parts of the parishes of Ecclesfield and Brinsworth and the site of the Sheffield sewage works have been added. Barnsley has been extended so as to include the urban districts of Ardsley and Monkbretton and of Worsborough, and part of the parish of Carlton. Rotherham's new boundaries include part of Rawmarsh, Greasbrough, Whiston, Dalton, Brinsworth and Wentworth. The electric supply powers of the three Corporations have been extended to the added areas.

The accounts of Nottingham Electricity Supply Department for the year ended March 31 show receipts from sale of current £198,997, and after providing for working expenses, the gross profit was £43,670, and the net surplus, after meeting capital charges, £11,383 (compared with a deficit of £8,912 in the previous year). The price of coal was 26 per cent. over that of 1919 and 179 per cent. over 1914. The new turbo-alternator and other plant, which should have been running last September, is expected to be working by the end of next month. The excess of the applications for supplies of current received during the year over the number of premises disconnected is 776. Total connections are equal to 659,520 32-watt lamps (increase 47,154). Units sold were 17,055,592 (increase 2,551,714).

The 27th annual report of Hull Corporation electricity department states that the gross income increased from £144,369 to £218,136. (51 per cent.) The units sold increased by 18 per cent., but expenses increased 32 per cent., and are exactly double the pre-war figures. The gross profit was £51,412, which, after payment of capital charges and £944 (a portion of the previous year's deficit), leaves £7,986 to carry to reserve. The net result, after providing sundry machinery, mains and meters for the extension of the undertaking, is a credit balance of £212. The engineer and manager (Major H. Bell) stated that since the close of the financial year there has been a further increase in the cost of fuel of over 16 per cent., with evidence of additional increase, so that it is quite impossible to continue on sound financial lines without a revision of the tariff. Proposals for increasing the charges will be made in due course. Last year the cost of coal advanced by 33½ per cent., but the increased cost per unit was 36 per cent., owing to the inferior quality of fuels available.

An interesting lecture on the history and development of electricity supply was given at Derby last week by Mr. T. P. Wilmshurst, borough electrical engineer. After referring to legislative and departmental restrictions in the past, Mr. Wilmshurst stated that in Derby in 1914 they were selling 7,000,000 units a year, of which 5,000,000 were used for power and 2,000,000 for lighting. In 1918 the output rose to 19,500,000 units, nearly 18,000,000 being for power, so that only about 7½ per cent. of the output of a large power station was used for lighting. Derby's power station would fit in with Government new requirements without the wholesale scrapping necessary in many large towns. He thought the financial estimates for the super-stations would stagger politicians. In regard to power station practice, one line of possible advancement was the adoption of gas-fired boilers, while experiments were being made on a large scale in another direction. A further line of investigation was the gas turbine as against the steam turbine.

The Manchester Electricity Committee has decided to purchase from Stockport Corporation the Heston Norris portion of their electric supply undertaking. Manchester Corporation has also arranged to furnish a bulk supply of electricity to Stockport for 10 years, and an application has been received from the Lancashire Electric Power Company for a supply to be furnished from the new power station at Barton.

The annual report of the Electricity Committee states that important additions to the electric generating plant have been carried out during the year, and big contracts have been placed for the Barton station and the various distributing stations in the city. On mains there has been a net addition of over 8 miles, and an extensive programme of new mains, including some 33,000-volt feeders, is being carried out this summer and autumn. The efficiency of the distributing system as a whole equalled 86 per cent., an increase of 1·82 per cent., and accounted for mainly by the falling off in sales of high-tension units since the Armistice. The recovery up to March, 1920, was much more pronounced in lighting, traction and ordinary power than in the case of special power users taking high-tension units.

Electric Traction.

The Greenock & Port Glasgow Tramways Company has revised its fares and abolished the popular half-penny stages.

The Metropolitan Electric Tramways, Ltd., have raised their fares, and in future the minimum will be 1½d. for two stages, with a 1d. for each additional two stages.

Sunderland Corporation are to undertake a road widening scheme on the Ryhope-road between Christchurch and Vilette-road, which will include the reconstruction of the tramways.

The Minister of Transport has extended for one year the times limited by London County Council Tramways and Improvements Acts for street widenings and completion of certain tramways.

The Brighton Corporation Light Railways Order, authorising the construction of light railways in Brighton and the rural district of Steyning East, has been submitted to the Minister of Transport for confirmation.

For the year ended March 31 the receipts of the Plymouth Corporation tramways were £135,695, and the gross profit was £20,961 ; but after defraying capital charges there was a net deficit of £1,742. Fourteen new tramcars are to be purchased at a cost of £28,000.

The Manchester tramwaymen, who recently received an advance of 9s. per week, have decided to demand a further increase of £1 per week. The Halifax Tramways Committee recommend the Town Council to give the tramwaymen the higher wages award of June 14, along with Leeds and Bradford, of 3s. per 48-hour week, instead of 2s. awarded to the group which includes Doncaster, York, Barnsley and Halifax.

The strike of the employees of the Llandudno & Colwyn Bay Electric Railway Company, which lasted over a week, was settled on the 16th inst., when the service was resumed. The men got an immediate advance of 3s. a week from May 1 and an undertaking by the directors to consider other matters in dispute. If fares can be increased and if Sunday running can be secured, the directors will grant a further increase of 3s. a week all round in three months' time.

The Light Railway Commissioners have submitted to the Minister of Transport for confirmation the amending Order for the construction of Light Railways in Wath-upon-Dearne and Bolton-on-Dearne in extension of the light railways authorised by the Dearne District Light Railways Order, 1915, reviving the powers granted by that Order, and extending the periods for the compulsory purchase of lands and for the completion of works, &c. Objections must be lodged by the 9th July.

Ayr Corporation has increased the tramway fares to the maximum permitted by statute, and application has been made to the Ministry of Transport for leave to increase the maximum fare from 1d. to 1½d. per mile. The revenue for the year ended May 15 last showed an increase of over £5,600, but owing to increased working costs, attributable mainly to an advance of 193 per cent. on pre-war wages, the year's working showed a deficit of £3,227, which had been taken from the reserve fund, reducing it to £1,772.

Imperial and Foreign Notes.

Pretoria Town Council has been authorised to raise a loan of £261,000 for the erection of a new electricity station of 6,000 kw. capacity and a sub-station of 3,000 kw. and for other public works.

Supplies of electrical equipment are now coming to hand regularly from abroad, and, consequently, much better progress is being made with the electrification of the Melbourne Suburban Railways. The Williamstown line will be ready shortly, and work is also progressing on the northern suburban lines. The next to be electrically operated is the Coburg line, to be followed by the Reservoir and Heidelberg sections.

According to the "Electrical Review," of America, army engineers are in favour of an additional diversion of water for Power Development at Niagara Falls and the Lower River Rapids. A request has been filed for the negotiation with Canada of a new power treaty, allowing of increased water diversion on both sides of the Niagara River. It is possible to produce on the American side with the present diversion 585,000 h.p. ; but it is believed that this can be increased to one million horse-power. The power at present going to waste represents a minimum of 15 million tons of coal a year.

Among the industries which the German State has nationalised are the various arms and munition works (which are now producing, under civilian management, agricultural machinery and tools), electricity supply and nitrate manufacture. The State took over from the A.E.G. the Bitterfeld electric power station, which has a capacity of 100,000 kw., and it has also acquired the Brown coal mines in Niederlausitz, the electrically-operated Lauta aluminium works, as well as a number of other power stations. The State has also secured control of almost the whole aluminium production and important Ilseder smelting works in Hanover.

Several Swiss Electric Supply Undertakings have recently decided upon increases of capital in order to provide for the demand for power. The Bernese Hydro-Electric Works will raise the capital from 32,000,000f. to 44,000,000f. ; the Altdorf Electricity Works from 1,000,000f. to 3,000,000f. ; and the Swiss Power Transmission Company from 6,000,000f. to 9,000,000f. Several municipal electricity works and the Central Swiss Power Works have decided to join the latter company, whose purpose is the co-operation of the electricity works for the better utilisation of water power. Under the style of Bündnerische Wasser-Kräfte A. G. (Grisons Water Power) a company has been founded in Thusis with a capital of 11,000,000f. for the amalgamation of several existing electricity and power works in the Grisons.

Miscellaneous.

The sixth International Aero Exhibition will be held at Olympia from July 9 to 20.

We regret to learn of the death of Mr. John Cooper, accountant of the Edison Swan Electric Company, Ltd. Mr. Cooper was in their employ for over 30 years.

The London Students' Section of the Institution of Electrical Engineers will visit Scotland this summer from July 21 until July 31. Apart from social meetings, the programme includes visits to the Dalmarnock Power Station of Glasgow Corporation, the Dykehead Colliery of the Summerlee Iron Company, the Rothesay Tramways Power Station and Depot, Messrs. Mavor & Coulson's works, the Engineering laboratories of the Royal Technical College and the University of Glasgow, &c.

We regret to record the death of Mr. Hammersley Heenan, J.P., M.Inst.C.E., late managing director of Messrs Heenan & Froude, Ltd. Mr. Heenan, who was born at Parsonstown, King's County, spent 16 years in India in the railway. In 1880 he returned and formed, with Mr. J. Froude, the well-known firm of engineers and bridge builders, of which he remained managing director until his retirement two years ago. He claimed to be the originator of the Channel Tunnel scheme.

The Summer Issue of the "Faraday House Journal" contains, in addition to the Report of the dinner of the Faraday House Old Students' Association and interesting items of domestic news, a short article on "Electrostatic Capacities of Concentric Conductors," by Dr. A. Russell.

The Research Association for the British Motor Cycle and Cycle Car industry has been approved as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The Secretary of the Committee engaged in the establishment of this Association is Major H. R. Watling, "The Towers," Warwick-road, Coventry.

In reply to a question in the House of Commons, Mr. Illingworth (Postmaster-General) has stated that the provision of a system of Automatic Telephone Exchanges for London presents peculiar difficulties. It is proposed to install one automatic exchange as soon as possible, and he hopes the experience thus obtained may make it possible to frame a complete scheme. The existing exchanges would be replaced gradually, and it would be some years before an automatic system for the whole of London could be completed.

The second annual re-union and dinner of the R.N.V.R. Wireless School, Crystal Palace, was held at the Holborn Restaurant, London, on the 19th inst. The O.C., Lt.-Col. C. G. Crawley, R.M.A.(ret.), M.I.E.E., Deputy Inspector of Wireless Telegraphy, G.P.O., took the Chair, and a most enjoyable evening was spent. Next year's re-union and dinner will take place in London about the end of April, on the day of the Football Cup Final, and all "old boys" are asked to send their addresses to Mr. N. J. Babbage, Rosieres, Hendon-lane, Finchley, N.3.

Apparently, the president of the newly-formed Amalgamated Engineering Union (Mr. J. T. Brownlie) has doubts about the economic effect of the reduced working day. Speaking at Oldham on Saturday, after giving statistics of the A.S.E., he said he wanted to see hours reduced to the lowest possible minimum consistent with industrial and social efficiency. Unfortunately they had no data to work upon in regard to hours, and a committee of investigation, composed of employers and workmen's representatives, had been formed to inquire into the economic relation of hours to work, and the methods of manufacture in this and foreign countries.

The Faculty of Engineering of the University of Bristol has recently issued a record of the occupations of former students. From the list, which runs to 36 pages, we learn that many of them are occupying prominent positions in the engineering world in all parts of the globe. An appendix to the record gives the positions held by certain students who were in the science department of the Merchant Venturers' Technical College before the establishment of the university.

By the new Ministry of Mines Bill, which was introduced into the House of Commons on Monday, it is proposed to create a new department of the Board of Trade under the control of an additional Parliamentary secretary. It is believed that a saving will be effected by this course in comparison with the cost of the present administration. Pit committees will be set up at each pit, composed half of employers and half of workers; a district committee in each district (of which there are 26 in the United Kingdom), an area board for each area, and a national board over all. Questions of wages, conditions, &c., will be dealt with by these various bodies. The new Secretary of Mines will have the benefit of the advice of an advisory council.

The extraordinary physical strength of the Mazda Drawn Wire Filament has, perhaps, never been better exemplified than in a recent accident on the Ayr Corporation tramways. A car collided with a motor car; the latter was smashed beyond recognition, the front of the tram-car being swisted and bent. In the middle of the dashboard (which sustained the full force of the collision) there was a headlight equipped with a Mazda traction-type lamp, and, although the glass front of the headlight was broken, and the bolts securing the metal framework sheered off, the Mazda lamp continued to burn after the accident. Railway and tramway companies, who use many thousands of Mazda lamps, have found that, on the average, they fully maintain their life and efficiency ratings, and give reliable service under the most adverse conditions. In spite of this actuarial method of assessing the qualities of electric lamps, corroboration of individual tests is none the less valuable, and when a lamp emerges triumphantly from such an ordeal as that at Ayr there can be little doubt as to its suitability for vehicular lighting.

A Congress of the Government and Local Roads Authorities will be held at the Hague from Sept 15th to the 26th of this year. The Congress will consist of Government engineers in charge of main roads, of provincial councils and engineers responsible for the smaller roads, and of municipal authorities. An important feature will be an exhibition of road-making materials, machinery, &c., and of commercial motors. In view of the development of road transport, the Exhibition Section of the Federation of British Industries has undertaken the representation of the Exhibition in England. The roads in Holland are chiefly constructed of "brick-stone," stone setts and ordinary macadam. No road-making machinery is manufactured in Holland, and there is no lorry manufacturer. The exhibits will cover everything connected with roads, including machines used in road-making and all the equipment necessary for beautifying and illuminating streets and thoroughfares, as well as motor lorries, commercial vehicles, spare parts, accessories, &c. Enquiries should be addressed to the Federation, 39, St. James's-street, London, S.W. 1.

Profits and profiteering are a prolific source of discussion and criticism at the present time. Much of this is unreasonable, and does not help us to find a solution of our difficulties. In this month's issue of the "Industrial League and Council Journal" there is a clearly reasoned article by Mr. E. J. P. Benn, C.B.E., on "Are Profits Necessary?" "It makes my blood boil," he says, "when I see some Polish Jew land on these shores, and within the space of a dozen or twenty years become a millionaire. There is something wrong with a system which will keep a highly educated man of science working all his life in comparative poverty, and allow an illiterate, vulgar, fat cosmopolitan financier to amass wealth to his heart's content. The capitalistic system, the profits system, will not, in my judgment, stand examination from the ethical point of view. Morals should exercise an influence over industry, as, indeed, they should influence all our actions. But to substitute morals for actions themselves does not, unfortunately, work out as we should like. It does not give us houses; it does not reduce prices; it does not increase supplies, and it does not add to our material comfort. Industry, to me, is something which is concerned with the feeding and clothing and housing of my wife and children; moral is, on the other hand, something which enables me and them to lead a better life. The two things are inexplicably mixed up together, but they are not, and never will be, substitutes one for the other. Taxation of all kinds does not, as is commonly supposed, reduce the rate of profits; it merely turns the profit-maker into a tax collector, and he, very naturally, charges another profit for collecting the taxes. But the commonest fallacy is that you can reduce profits by increasing wages, or that wages come out of profits, or profits out of wages. Nothing of the kind is, in fact, true. I, therefore, come to the conclusion that, in the present state of development of the human race, there is no more chance for platonic industry than there is for platonic love, and I do not want to see civilisation destroyed and the human race reduced to savagery and starvation by the chasing of an ideal which may apply to angels, but cannot apply to mere mortals. If, instead of endeavouring to exterminate the profiteer, we were to encourage him, there would be so much competition among profit makers as to reduce profits to an economic level. That is the business like thing to do." The "Journal" also contains other interesting articles, including those on "Profit Sharing" and "Economical Production and Prevention of Waste."

Telegraph and Telephone Notes.

It is announced that new wireless telegraph stations on the Mount of Olives will be able to communicate directly with Paris and London.

In view of the urgent importance of free movements of ships, the Board of Trade has notified shipowners that, during the Strike of Wireless Operators, owners of vessels of over 1,600 tons register, which normally are required to carry wireless operators, will not be proceeded against for a breach of the regulations if they send their vessels to sea without operators.

A Select Committee has been appointed to examine the present telephone charges and to report in what respect these charges require revision in order to place the service on a remunerative basis. The members of the Committee are Sir Edward Coates, Sir Harry Brittain, Mr. E. M. Archdale, Capt. Sir Ian Hamilton Benn, Mr. Briant, Mr. Tyson Wilson, Mr. John Robertson, Mr. W. T. Carr and Mr. Purchase. The Chairman is Sir Edward Coates.

Catalogues, Price Lists, &c.

Messrs. Donald H. Scott & Co., Ltd., 10, Arthur-street, E.C.4, have issued their list of "Invicta" varnished fabrics, insulating materials, &c.

A pamphlet describing the properties and uses of the Acheson graphite lubricants "Oildag" and "Gredag" has been issued by Messrs. E. G. Acheson, Ltd., 5, Chancery-lane, W.C.2. Oildag is used by many electrical and mechanical engineering firms, and it is claimed that its employment ensures the smooth running of machinery and reduces operation costs.

Booklet No. 7, just issued by the Vaughan Crane Company, Openshaw, Manchester, contains full particulars of the design and construction of the Vaughan patent electric block. The information includes a specification, diagrams of dimensions, tables of speeds, weights, prices, &c. The blocks, which are standardised in three frames sizes, can be used for varied classes of work—for hoists, travelling blocks, cranes of the overhead travelling or wall jib types, &c. Several hundreds are already in use and illustrations of some typical application of the electric block are given.

Personal and Appointments.

Prof. F. W. Burstall has been elected Dean of the Faculty of Science of the University of Birmingham, in succession to Sir John Cadman.

Mr. S. M. Teal has been appointed deputy chief engineer of the Calcutta Electric Supply Corporation.

Mr. E. Morgan, of Dewsbury, has been appointed assistant electrical engineer at Wolverhampton at £500 per annum.

Ayr Town Council has granted the electrical engineer (Mr. R. Marshall) a bonus of £150, and the tramway manager (Mr. W. Grant) a bonus of £135, into which all war bonuses are merged.

Last week members of the Liverpool Tramways Committee presented a silver rose bowl, salver and vases to Mr. C. W. Mallins, who recently retired from the position of tramways manager. Councillor F. C. Wilson, chairman of the Committee, made the presentation, and referred to Mr. Mallins' long connection with the tramways undertaking and to his ability as an administrator.

In reply, Mr. Mallins thanked the Committee for the whole-hearted support they had always extended to him during the whole of his career. When he joined the service in 1874 there were only 18 tramcars running in Liverpool. He referred to the periodic changes in the types of vehicles used for passenger transport. He considered that in the future the various passenger transport systems of the city should be co-ordinated.

Business Items, &c.

Mr. J. Allan Wilson has resigned his position as branch manager of Messrs. Johnson & Phillips' Glasgow office as from June 30 next.

Mr. W. Johnston has, with his son, commenced business as electricians at 20, St. Andrew-street, Kilmarnock, under the style of William Johnston & Son.

Mr. R. Millett has been recently appointed by the Electric Construction Company, Ltd., Wolverhampton, as their sole Lancashire and Yorkshire agent, with offices at 30, Cross-street, Manchester. Tel.: City 7772.

The partnership carried on by Geo. Wheeler and W. Ison, electrical and mechanical engineers, Holmleigh, Whippendell-road, and 190, Harwood's-road, Watford, under the style of Wheeler & Ison, has been dissolved as from May 31.

The partnership between Wm. Townsville Baker, Hartop W. Baker and Harry Hyman (trading as Baker & Hyman), electrical manufacturers, &c., 11 and 13, Portland-crescent, Leeds, has been dissolved so far as concerns Mr. H. W. Baker. Debts by Messrs. W. T. Baker and H. Hyman, who continue the business.

In 1915 Messrs. Buck & Hickman established a training centre at 3, Adler-street, London, E. 1, for instructing operators in machine tool work in connection with the manufacture of munitions. This centre has now been transformed into peace time uses, and there will be found a number of Messrs. Buck & Hickman's well-known machines operating under proper working conditions. A means is thus provided whereby an intending purchaser can see the machine he proposes to buy running under operation on his own work. All interested in modern machine tools and methods are invited to call at the centre.

Bankruptcies and Liquidations.

A meeting will be held at 62 and 63, Queen-street, London, E.C. 4, on July 12 to receive an account of the winding-up of the TORQUAY TRAMWAYS CONSTRUCTION SYNDICATE, LTD.

The SURREY ELECTRICAL COMPANY, LTD., is being wound up voluntarily, and Mr. E. W. E. Blandford, 227-8, Gresham House, Old Broad-street, London, E.C. 2, has been appointed liquidator.

The Telephone Mfg. Company, Ltd., is being wound up for reconstruction purposes, and Messrs. F. T. Jackson and C. W. Rooke have been appointed liquidators. The new company's title will be the Telephone Mfg. Company (1920), Ltd.

In a statement issued by the liquidator of F. Husband, Ltd., it is stated that the estimate of the value of the stock given at the recent meeting of creditors was too high and that it is unlikely the sum mentioned (£2,500) will be realised. The company did fairly well with their patent heating apparatus for a time, but they had trouble in obtaining supplies. There will be a substantial deficiency as regards the debenture holders claims and therefore there is little prospect of a dividend for creditors. Mr. W. A. J. Osborne, 119, Finsbury-pavement, London, E.C., has been appointed liquidator of F. Husband, Ltd., with a committee of inspection, in place of Mr. R. S. Farries, who has retired.

"The Electrician" Electrical Trades' Directory.

The 38th (1920) edition of "THE ELECTRICIAN Electrical Trades' Directory and Handbook" is now available, and copies are being dispatched to subscribers as rapidly as possible. We greatly regret the delay in the publication of the Directory, which is solely due to the paper and printing difficulties; but effective steps have been taken to ensure its regular appearance in future. Both the Handbook and Directory Divisions of the "Big Blue Book" have been carefully revised: many new firms have been added to the alphabetical section, while the Classified Trades' Section has been improved and extended. The price of the new edition is 25s. net, post free 25s. 9d.

The new edition of THE ELECTRICIAN TABLES OF ELECTRICITY UNDERTAKINGS (British, Colonial and Foreign) is also available, price 10s. net. Reviews of the Directory and of the Tables will appear in our next issue.

Tenders Invited and Accepted.

EDINBURGH Corporation invite tenders for electric lighting installations in dwelling houses under their new housing scheme at Gorgie. Tenders to Town Clerk by July 13.

MIDDLESBROUGH Corporation require tenders by July 6 for three, six or nine months' supply of electric lamps, rubber goods, &c. Specifications from the Borough Engineer.

WOOD GREEN Council require tenders by noon July 13 for electric wiring and fitting in the Town Hall and Bound's Green-road Schools. Specifications, &c., from the Clerk of the Council.

MIDDLESBROUGH Corporation require tenders by first post July 6 for three or six months' supply of electric lamps, rubber goods, oils, paints, &c. Specifications, &c., from the Borough Engineer.

The NEW SOUTH WALES DEPARTMENT OF PUBLIC WORKS, Sydney, require tenders by Aug. 2 for the supply of turbines and generators for the Barren Jack hydro-electric development.

SYDNEY (N.S.W.) require tenders by 3 p.m., July 19, for the supply of maximum demand indicators. Specifications from the Electric Lighting Department, Town Hall, Sydney.

WARRINGTON Electricity and Tramways Committee require tenders for two 6,000-kw. turbo-alternators. Specifications from the Borough Electrical Engineer and tenders to Chairman of Committee by July 13.

DURBAN (Natal) Corporation invite tenders for supply and delivery of eight petrol or electric road wagons. Specifications from, and tenders to, Messrs. Webster, Steel & Co., 5, East India-avenue, London, E.C., by July 7.

HULL Electricity Committee invite tenders for supply and erection of an electrically-operated overhead travelling crane. Specifications from the City Treasurer and tenders to the Chairman of the Electricity Committee, Guildhall, Hull, by noon July 12.

The VICTORIAN RAILWAY COMMISSIONERS require tenders by July 14 for track relays (contract 33,055) and twin-wire cable (contract 33,056) for power signalling; also by July 28 for a three-phase crane motor for N. Fitzroy sub-station. Specifications from the Commissioners' Offices, Spencer-street, Melbourne.

The date for the receipt of tenders by the NEW ZEALAND PUBLIC WORKS DEPARTMENT for synchronous condensers, service transformers and three-unit motor generator in connection with the Lake Coleridge hydro-electric undertaking is extended from June 30 to July 30.

TOTTENHAM District Council require tenders for supply and erection of electric motor charging plant, &c. Particulars from Capt. H. F. Wilkinson, R.E., engineer of the Council, Town Hall, Tottenham, N. 15. Tenders to the clerk and solicitor (Mr. Reg. C. Graves) by noon, July 1.

GLASGOW Corporation invite tenders for supply and erection of a 10,000 kw. steam turbo-alternator, with condensing plant, for the tramways department. Specifications from the general manager, Mr. James Dalrymple, and tenders to the Town Clerk, Mr. J. Lindsay, by July 6.

The Tramways and Electricity Committee of HALIFAX Corporation invite tenders for the supply and delivery of two natural draught chimney-type water-cooling towers. Specifications from the borough electrical engineer (Mr. W. M. Rogerson) and tenders to the town clerk (Mr. Percy Saunders) by noon, July 8.

Tenders are required (by Aug. 3) for the supply and erection at Perth (W.A.) of 326 accumulators (in accordance with Schedule W.A. 668), and also (by Aug. 2 and 5 respectively) for (A) aluminium sheet, brass rod, &c. (schedule 769) and (B) platinum wire, gold and silver wire, &c. (schedule 768), for the AUSTRALIAN COMMONWEALTH, POSTMASTER-GENERAL'S DEPARTMENT, New South Wales. Forms, &c., from the High Commissioner, Australia House, Strand, London, W.C. 2.

MALTON (Yorks.) Urban Council has accepted the tender of the Northern Counties Electricity Supply Company for lighting 124 50-c.p. lamps for three years, at £580 12s. 6d. per annum.

BURNLEY Electricity Committee recommend the Council to place the contract for the proposed extensions to the electricity works with the English Electric Company at £107,400.

SUNDERLAND Corporation has accepted the following tenders:—Jas. Howden & Company, new parts for A.E.G. turbine; Elliott Bros., test room instruments; General Electric Company, rotary converters and seven circuit breakers; British Insulated and Helsby Cables, Ltd., cable wagon, E.H.T. cable, and four core L.T. network cable; C. C. Wakefield & Company, turbine oil; Ferranti, Ltd., house service meters, and Clarke, Chapman & Company, new boiler house plant.

SHOREDITCH Lighting Committee has been auhtorisdd.to accept the tender of the Metropolitan-Vickers Electrical Company for a 5,000-kw. turbo-alternator with condensing plant, at £39,095 (efficiency at full load 13·13 lb. of steam per kilowatt-hour; delivery in 56 weeks). C. A. Parsons & Company and the British Thomson-Houston Company also tendered at £43,000 and £39,880 respectively. Ten tenders were received from British, two from Swiss and one from Swedish firms, but, owing to low efficiency or high price, all except the three above-mentioned were deemed unworthy of consideration. The Committee has also accepted the tenders of the Stirling Boiler Company, at £16,550, for a marine type water-tube boiler, with chain-grate stokers, superheater, economiser, steel chimney, &c. The same company also tendered for a land type boiler at £15,850; Clarke, Chapman & Company submitted three offers at £18,196, £18,105 and £17,740; Babcock & Wilcox, two at £16,620 and £15,960; and the Baldwin Locomotive Company, one at about £18,500.

Patent Record.

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

January 26, 1920.

2,354 Foster. Tumbler switch.
2,356 Moore. Relays for protective and operating gear.
2,372 Etchells & Greaves. Electrical resistance furnaces.
2,378 Cranmer, Cheshire & Summernaye. Electrically heated irons.
2,382 Chambers. Directive radio telegraph or telephone receiving systems.
2,383 Emmerson. Rendering switches, lampholders, &c., visible in dark.
2,396 Gascoyne. Three-light switch.
2,402 Watson. Combined reflector shade and lamp lock for electric lamps.
2,440 Fisher. Telephone switchboards
2,442 Thomas. Magnetic materials.

January 27, 1920.

2,461 Blondy. Electric pocket lamps. (20/2/19, France.)
2,472 Cowper-Coles. Process for manufacture of incandescent lamps.
2,492 Salthouse. Machine to obtain continuous currents without commutator, &c.
2,504 Electrical Improvements, Ltd. & Beard. Protective arrangements for electric distribution systems.
2,521 Lyon. Electric heater.
2,525 Siemens Schuckertwerke. Magnet coils. (19/10/18, Germany.)
2,528 Edwards. Electric foot and food warmer
2,542 B.T.-H. Co. (G.E. Co.) Protective devices.

January 28, 1920.

2,608 West. Electric lamp fitted with shade or reflector.
2,636 Crowther, Osborn & Pattison. Incandescent lamps.
2,655 Wassell. Electric burglar detainer.
2,657 Norske Aktieselskab fur Elektrokemisk, Industri Norsk Industri-Hypokkbank. Suspension of electrodes in furnaces. (28/1/19, Norway.)
2,666 Bayley & Taylor. Fittings for holding incandescent lamps, &c.
2,687 Portholme Aircraft Co. & Haghton. Wireless telegraphy and telephony.,
2,688 B.T.-H. Co. (G.E. Co.) Resistances.
2,703 Meston. Continuous Electrical-mechanical filter.
2,710 Fletcher. Electro-deposition of metals on iron, &c.
2,712 American Bosch Magneto Corpn. Magneto-electric ignition apparatus. (8/11/19, U.S.)
2,724 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Switches.
2,726 Kettelwell & Vidal. Securing field magnets of electric machinery.
2,727 Uhlig. Magnetic separators. (10/10/19, Germany.)
2,730 Cattle & Thornewell. Connecting devices for electrical apparatus, &c.

January 29, 1920.

2,781 Siemens-Schuckertwerke. Speed control for electric machinery. (3/7/17, Germany.)
2,808 Brydon. Electric control systems.
2,816 Berry. Sockets or caps for incandescent lamps.
2,818 Cash & Davis. Detachable fixture for electric pendants, &c.
2,822 Berry. Transformers.
2,824 Pyne. Electro-mechanical attachments for indicating vacant seats in theatres, &c.
2,839 Hulbert. Electrical resistance control.
2,850 Telephone Mfg. Co. & Stott. Intercommunication, &c., telephones.

January 30, 1920.

2,858 Taylor. Distribution on single-phase and two-phase alternating-current systems.
2,889 Cowen. Frictional electrical machines.
2,901 Thompson. (Compagnie Generale de Telegraphie et de Telephonie.) Conduits, &c.
2,902 Goldschmidt. Excitation of oscillating circuits. (18/11/13, Belgium.)
2,919 Combini. Switches. (8/2/19, Italy.)
2,931 Siemens-Schuckertwerke. Alternate-current systems. (26/11/18, Germany.)
2,956 B.T.-H. Co. & Pollock. Electric machines.
2,957 B.T.-H. Co. (G.E. Co.) Electrical systems and power transmission and regenerative braking.
2,971 Maur. Electro-magnetic control arrangements. (8/2/19, Switzerland.)

January 31, 1920.

2,983 Henshaw & Hinks. Combined electric lamps and condensers for kinematograph projectors, &c.
3,000 Brilloni. Transmission by high frequency currents. (31/1/19, France.)
3,0[illegible]1 Siemens Bros. Dynamo Works & Howard. Windings for electric machines.
3,053 Sykes. Recording sound transmitted telephonically.
3,068 Ditcham. Wireless transmitters.
3,070 Henley's Telegraph Works Co. & Roberts. Insulation of conductors.
3,073 Trabet. Switches. (16/9/19, France.)
3,076 Meyer. Electric lamps for use in presence of explosive gases.
3,077 Johansson. Connectors for electrically heated apparatus. (24/2/19, Sweden.)
3,078 Johansson. Electrical connectors. (7/11/19, Sweden.)
3,081 Siemens-Schuckertwerke. Cooling arrangements for electrical machinery. (7/10/18, Germany.)

February 2.

3090 Furze. Luminous current indicating apparatus for electric irons, &c.
3121 Pearse. Electric reciprocating engine.
3132 Fritze. Continuous current generator for constant intensity of current.
1356 Berry. Electric fires.
3168 Cox. Submarine telegraphy.
3186 B. T.-H. Co. (G. E. Co.). Induction apparatus.
3197 Ramsay. Electric generators or motors.
3217 Tagliaferri. Electric furnaces.
3218 Appleton & Macrorie. Reception of continuous waves in wireless telegraphy.
3219 Irving & Macrorie. Wireless telegraphy and telephony.
3220 Macrorie & Shearing. Relays for valve sets in wireless telegraphy and telephony.
3221 Macrorie, Appleton & Long. Detection of high frequency currents for wireless telegraphy and telephony.
3222 Long & Macrorie. Low frequency amplification in electrical circuits for wireless telegraphy and telephony.
3223 Airey & Macrorie. Holders for valves in wireless telegraphy.
3224 Airey & Macrorie. Thermionic valves and their circuits.

February 3.

3231 Taylor. Distribution single and two-phase alternating current systems.
3248 Cowper-Coles. Leading in wires and filaments for electric lamps.
3286 Callaway. Incandescent lamps.
3292 Gush. Insulators for electrolytic systems.
3305 B. T.-H. Co. (G. E. Co.). Cooling devices for electrical apparatus.
3307 Harman & Le Bas. Electrically-driven machines.
3312 Boorne. Electrodes for arc welding and metal cutting.
3336 Aktieselskabet Jydsk Elektro. Alternating current machines. (12/4/19, Denmark.)
3347 Woosnam (Naamloose Venoots, Metaaldraadlampenfabrick, Holland). Incandescent lamps.
3348 Mathieu. Electric valve on lamp relay and inter-valve transformer.
3350 Waldner. Incandescent lamps.
3352 Telephone Mfg. Co. (J. Murray). Telephones.
3358 Irving & Macrorie. Transformers for wireless telephony.

February 4.

3360 Boulton & Paul & Pfiske. Internal combustion engines and self-contained electric lighting units.
3375 Deutsche Gasgluhlicht Akt. Ges. Tungsten incandescent lamps. (17/2/19, Germany.)
3413 Handley. Electric switches.
3428 Hinks. Reception of telegraphic signals.

Companies' Reports, &c.

Meeting of Callender's Cable & Construction Company.

The twenty-fourth ordinary general meeting of this company was held on the 17th inst., Sir J. Fortescue Flannery, M.P., M.Inst.C.E. (Chairman), presiding.

In moving the adoption of the report and accounts (abstracted in our issue of June 11), the Chairman said when it was remembered that the results had been achieved in the face of unusual difficulties they were more than satisfactory. The war for over five years made things difficult for the company. As a result of the suspension of hostilities the Government stopped their war orders within 24 hours and left on their hands large quantities of partially-manufactured material and also a factory which had been built to meet the Government's special requirements. Their original factories, which had been converted to meet the special requirements of the Government, were, to a large extent, in a condition unsuitable for commercial work. The problem, therefore, was to obtain orders sufficient to fill their works, re-arrange the factories to make such work profitable, and to enable the company to keep their promise to re-engage and re-employ over 800 men. It was a testimony to the inherent strength of the company that its world-wide agencies, its sale organisation and the skill and grit of its management (led by Sir Thomas Callender) enabled it to secure the orders, deliver the goods and obtain the profit shown by the accounts. That profit was earned after the changes referred to had been made, and consequently during a portion only of the year.

Operation of Works by Shifts.

The present year was handicapped by no such difficulties, and they expected corresponding improvements in results. The volume of orders received was colossal and quite beyond the capacity of their factories working for 47 hours a week only, and it was clear that the fullest employment of the plant must be obtained to achieve the delivery to time of the large contracts for cable which were placed in their hands. After prolonged and difficult negotiations a scheme of rotary shifts for their cable shops was agreed, so that the cable works could, to all intents and purposes, keep up a continuous process of manufacture. Such an arrangement enabled them to deal with the extraordinary volume of orders and to a limited extent with some improvement in the cost of manufacture. All that augured well for the company's future. Large contracts had been secured and others were apparently coming their way, the output of the works was continuously increasing, and a new factory had been erected at Erith to manufacture super-tension cable, the demand for which was already urgent and was bound to develop.

New Capital Required.

The directors intended to seize the opportunity before them to drive ahead the enterprise along the path of even more successful progress. To do so, however, financial resources beyond those already possessed by the company were necessary, and in a few days' time the board would appeal to the shareholders and to the public to provide them with further funds to develop further that successful business. They proposed to issue 400,000 7½ per cent. "B" preference shares of £1 each at par, and 100,000 ordinary shares of £1 each at 22s. per share.

Proceeding to give an analysis of the year's accounts the chairman said the balance to the credit of profit and loss account was £161,000, compared with £134,000 a year ago. After provision for interest, preference dividend and depreciation, and adding balance brought from 1918 the available total was £198,000, compared with £184,000. They were carrying to special reserve for war taxation £33,000, and after payment of a dividend for the year of 15 per cent. on the ordinary shares they were carrying forward £105,000. The excess profits duty at 60 per cent. was a terrible impost on industry; it must tend to check enterprise and must cripple industry to a considerable extent. It was to be hoped that the discussions now going on might enable the Government to see their way to make some reduction of this very serious taxation.

Sir T. O. Callender (managing director) seconded the motion and said that 1919 had admittedly been a year of great effort and very hard work in view of the change of circumstances under which the company had had to operate, and he wished to acknowledge the great help he had received from all the members of the staff. In every direction they had endeavoured to push the interests of the company. They had opened up new connections—even in the somewhat unlikely country of Iceland they had succeeded in opening up a small but satisfactory business account. They had pushed ahead in South America, where they had opened their own offices on the West Coast with what he hoped would be very satisfactory results. They had widely extended their field of operations in India and he was confident there would be much business there. The new factory for the manufacture of super-tension cable would relieve the strain on the existing workshops to a considerable extent and give them an entirely new field of operations. He hoped that before the present month closed they would be actually making that cable in the new shops. The running of their cable factories continuously, although not giving them all that one would expect from the inexperienced talk in a more or less scientific Press, did at least give them a very considerably increased output. In their engineering shops the restrictive policy of the trades union prevented anything of the kind taking place, and the union were still adamant in their determination that no man should work more than the fixed number of hours. At times that caused great inconvenience and very serious loss, but there were already glimmerings of common sense from the other side which they hoped would enable them to do better in the engineering department than in the past.

The report and accounts were adopted, the dividends recommended were approved and the retiring director (Mr. John Varley) was re-elected.

The company is making an issue of 400,000 7½ per cent. "B" cumulative preference shares of £1 each at par, and 100,000 ordinary shares of £1 each at £1 2s. per share, in order to provide funds for the erection of additional workshops at Erith and the provision of further working capital necessary in consequence of the large increase in the turnover of the company and of its subsidiary, the Anchor Cable Company.

We learn that the application for 160,000 ordinary shares in Messrs A. Reyrolle & Company, Ltd., closed on the 19th inst., the amount required being over-subscribed.

The Castner-Kellner Alkali Company, Ltd., has declared an interim dividend at the rate of 20 per cent. per annum for the six months ended March 31, compared with 12 per cent. in 1919.

The directors of the Dublin and Lucan Electric Railway Company have declared a dividend of 5s. per share on the 5 per cent. preference capital on account of arrears for the year ended Dec. 31, 1919.

The preference share and transfer books of the Automatic Telephone Mfg. Company, are closed from the 16th to 25th inst. inclusive, fo preparing the dividend warrants on the 6 per cent. preference shares for the half-year ending 30th inst.

The directors of the Eastern Extension Australasia & China Telegraph Company, Ltd., have declared an interim dividend for the three months ended March 31 last of 5s. per share, payable (tax free) on the 15th prox. The share register will be closed from July 7 to 14.

The Eastern Telegraph Company, Ltd., announce the payment on the 15th prox. of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending June 30, and a first quarterly interim dividend at 2½ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1920. The transfer books of the ordinary stock will be closed from July 7 to 14 inclusive.

The profit of Waygood Otis, Ltd., for the year ended March 31, after providing for all expenses and depreciation, was £48,761, which with £8,030 brought forward makes £56,791. There has been placed to reserve accounts £11,500, pension fund £3,000, and the directors recommend a dividend for the year of 7½ per cent. on the ordinary shares, carrying forward £14,446.

The report of Messrs. Ransomes, Sims & Jefferies, Ltd., for the 15 months ended March 31 states that, after charging depreciation and making provision for bad and doubtful debts, and also after deducting debenture interest, &c., the profit is £46,676. The preference dividend to March 31 absorbed £13,750, and after adding balance from 1918 (£41,437) the total is £74,363. The sum of £15,650 has been placed to reserve, and the directors recommend that £22,359 should be applied in paying a dividend on ordinary shares of 5 per cent. per annum, leaving £36,353 to be carried forward.

The directors' report of the Direct Spanish Telegraph Company, Ltd., for 1919 states that, after payment of income tax and excess profits duty for 1918, and including sum brought forward, the available balance is £34,793. It is proposed to pay a dividend on the ordinary shares at 7 per cent. per annum and a bonus of 3 per cent. (both free of tax), to transfer £5,000 to reserve fund and carry forward, subject to excess profits duty, £20,328. Two interruptions of the Bilbao cable occurred during the year, and the necessary repairs were duly effected after interruptions of 37 and 17 days respectively. The cost of the two repairs (£36,494), which includes the renewal of 150 knots of old cable, has been charged to revenue.

During the year 1919 the South Wales Electrical Power Distribution Company sold 45,127,985 units, compared with 36,593,903 in 1918, an increase of 8,534,082. The undertaking is operated by the Treforest Electrical Consumers Company, and particulars of receipts and expenses are given in the accounts of that company. After payment of all expenses, the credit balance of the year's working was £25,627, which, with £2,670 to credit of suspense account, makes £28,297. Deducting interest on prior lien debenture stock and the original debenture stock, and making provision for depreciation of the new plant, there remains £676 to be carried forward.

Messrs. J. G. White & Company, Ltd., report a net profit of £28,052 for the year to Feb. 29, 1920. During the year the company amalgamated its construction department with that of Dick, Kerr & Company, and the Consolidated Construction Company will carry out all current construction contracts of Dick, Kerr & Company. The whole of the capital of the new company is owned hy J. G. White & Company, and the management of it is under its supervision. The balance to credit of profit and loss, after bringing in £33,333 from the previous account and deducting the interim dividend paid on the preference shares, is £55,086. The directors recommend a dividend of 3½ per cent. on the 7 per cent. cumulative preference shares for the half-year (making 7 per cent. for year), and a dividend of 7 per cent. on the ordinary shares for the year (July 1), placing to reserve £30,000 and carrying forward £15,286.

It was announced at the meeting of Brunner, Mond & Company, Ltd., last week that the company held 91 per cent. of the total capital of the Castner-Kellner Alkali Company, and an agreement had also been made with the Electro-Bleach & By-Products, Ltd., for an exchange of shares in the two companies. In consequence of those transactions the issued capital of the company had been increased by £1,497,241, making a total issued capital of £10,967,621. Their practice had been one of high production and low prices, and they intended to carry out that policy in those amalgamations. The dividend for the year would be 11¼ per cent., compared with 10 per cent. in the previous year. Reference was also made to the formation of the Synthetic Ammonia & Nitrates, Ltd., with a capital of £5,000,000 to acquire from the Ministry of Munitions the works at Billingham for the erection of plant for the fixation of nitrogen from the air on a modified Haber process

The gross receipts of the Anglo-Argentine Tramways Company, Ltd., during 1919 were £3,296,957 and the expenditure was £2,578,516. Adding interest on investments and deposits, &c. (£39,521), and amount brought forward (£83,043), and deducting annuity to City of Buenos Ayres Tramways Company (£70,000), interest and sinking funds on debenture stocks (£587,821), &c., the balance is £175,510. The directors recommend a dividend of 5½ per cent. be paid on the cumulative first preference shares (being arrears for year to June 30, 1918), leaving £52,309 to be carried forward. The traffic receipts increased by 6·52 per cent., though there were two interruptions of services by strikes. The number of passengers carried was 370,734,985, an increase of 6·14 per cent. The operating expenses increased by £198,178, occasioned by the extra cost of materials, higher wages, &c. The company has been authorised to increase tariffs from 10 to 12 cents, to take effect as from April 10 last.

For the year ended March 31 the gross profit of the British Electric Traction Company, Ltd., was £246,717, compared with £250,213 19s. 9d. in 1918-19. After deducting general expenses (£35,401), the net profit was £211,316, and with £130,952 brought forward the total is £342,268. Deducting debenture stock interest (£87,996), the balance is £254,272. The directors recommend that £8,035 be placed to reserve, that a dividend of 6 per cent. for the year be paid on the cumulative participating preference stock and a dividend of 4 per cent. for the year upon the ordinary stock, leaving to be carried forward £150,422. The aggregate receipts of the Associated Companies continue to show an increase, which is, however, more than offset by the increased cost of operation, due to the continued rise in the price of materials, in wages and the introduction of the 48-hour week. The amount standing to credit of reserve account is now £500,000. The investments, which now stand at £4,027,792, show a decrease of £255,944, compared with the previous year, due to sales of undertakings and realisation of investments. The investments yielded a revenue of £212,747, representing an average of 5·28 per cent. for the past year on the amount at which they appear in the balance sheet, compared with 5·08 per cent. for the preceding year.

The net revenue of the Globe Telegraph & Trust Company, Ltd., for the year ended May 31, after deduction of expenses, amounted to £263,950, and with £1,629 brought forward, the total is £265,579. A sum of £7,000 has been transferred to reserve for contingencies, and £111,393 has been distributed in interim dividends, leaving an available balance of £147,186. The directors now recommend payment of the following final dividends, viz.: 3s. per share on the preference shares, making, with previous distributions, a total dividend for the year at rate of 6 per cent. per annum (less tax) and 14s. per share on the ordinary shares, making, with previous distributions, a total dividend at the rate of 10 per cent. (tax free for the year). These dividends will absorb £145,807, leaving £1,379 to be carried forward. During the year under review the Eastern, the Eastern Extension and the Western Telegraph Companies issued new capital, which they offered at par to their existing stock and shareholders. The directors decided to take up the whole of the allotments to which the company was entitled; and, in order to enable them to pay for same, issued 60,376 of the unissued ordinary shares at par to the existing ordinary shareholders. During the same period the whole of the company's holding in the Central & South American Telegraph Company was sold; also £4,300 Anglo-American Telegraph Company's preferred stock; while 141 certificates of the Submarine Cables Trust, belonging to the company, were drawn and paid off. The proceeds have been re-invested in the stock and shares of the Eastern, Eastern Extension and Western Telegraph Companies.

Mr. Godfrey C. Isaacs, who presided over the annual meeting of the Marconi International Marine Communication Company, Ltd., on Friday, said they proposed to pay a final dividend of 10 per cent., and to carry forward £161,890, subject to excess profits duty for the years 1916-17-18-19. The number of ships installed at the end of December was 2,842, compared with 2,549 in 1918. The past year had been a somewhat difficult one in consequence of the dismantling of a great many ships following the cessation of war. The receipts from ships' telegrams had not yet reached normal conditions. The cost per word for sending a message from this country to a ship at sea was 10½d. Of that amount 6½d. per word belonged to the Post Office and 4d. per word to the ship station. Of that 4d., 2d. went to the shipowners and 2d. to the company. The direction finder had been further improved, and was now becoming a really valuable device in assisting navigation.

Mr. Isaacs dealt at some length with the strike of wireless operators, and said that during the war they met the Association of Wireless Telegraphists, and eventually increases were accorded them which, including war bonuses, amounted to 142 per cent. upon pre-war rates for every man in his first year of service. In addition, other improved conditions were conceded. They were obliged, of course, to confer with shipowners before these terms could be accorded. It was an extraordinary fact that until they were officially advised that the strike had commenced they had no notification from the Association of Wireless Telegraphists that they were about to call a strike. The demands now made would, if acceded to by the company, represent an annual payment of about £500,000 sterling. A matter of that vast importance, he said, could only be dealt with at a conference, and "if the conference takes place what is fair and equitable will be conceded by all, but so long as the men are on strike committing breaches of agreements with us, and threatening to hold up the whole of the mercantile shipping of the country, no conference is possible."

New Companies.

A. R. ENGINEERING COMPANY (SOUTHAMPTON), LTD. (167,986).—Private company. Reg June 4, capital £1,000 in 5s. shares, to carry on the business of engineers, electricians, &c. First directors are: J. B. Webb (chairman), H. Walker and A. E. Webb. Reg. office: 126, High-street, Southampton.

BOUGIE POGNON, LTD. (168,249).—Private company. Reg. June 14, capital £100 in £1 shares, to acquire and turn to account the patent and trade mark relating to the Pognon Sparking Plugs. Solicitor, A. Baker, Lennox House, Norfolk-street, Strand, W.C.

BUKWOOD ENGINEERING COMPANY, LTD. (168,084).—Private company. Reg. June 8, capital £1,000 in £1 shares, to carry on the business of tool makers, general and electrical engineers, &c. First directors are: G. St. J. Wood, H. S. Kemshead and W. J. Butler. Reg. office: 31*a*, St. Jude-street, Stoke Newington, N. 16.

CITY ELECTRIC WELDING COMPANY (NEWCASTLE), LTD. (167,863.)—Private company; reg. May 31, capital £5,000 in £1 shares, to carry on the business of electric and oxy-acetylene welders, automobile and marine engineers, ship builders and repairers, &c. First directors, A. Atkinson, W. C. Waller (and Secretary) and C. Deuchar. Reg. office, 2 and 4, Stephen-street, Bridge End, Byker, Newcastle-on-Tyne.

CONCORD ENGINEERS, LTD. (11,158.)—Private company; reg. in Edinburgh April 22, capital £5,000 in £1 shares, to carry on the business of consulting, mechanical, motor and electrical engineers, &c. Solicitor, A. Mackenzie, 174, West George-street, Glasgow.

UNIVERSAL WELDING COMPANY, LTD. (168,144).—Private company, Reg. June 9, capital £4,000 in £1 shares, to take over the business of engineers, ironfounders and welders carried on at Manchester as the "Universal Welding Company." Permanent managing directors are: J. T. Harrison and C. Harrison. Reg. office: 17, Houldsworth-street, Oldham-street, Manchester.

WELDUM, LTD. (168,114).—Private company. Reg. June 8, capital £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in fluxes for the brazing and welding of cast iron, steel and other metals, general and electrical engineers, &c. Acting secretary: A. F. Alsop. Reg. office: 67, Cleethorpe-road, Grimsby.

WESTERN ANGLO SWEDISH ELECTRIC WELDING COMPANY, LTD. (167,396)—Private company. Reg. May 12, capital £25,000 in £1 shares, to carry on the business of electric and other systems of welding, engineering, dealing in plant, machinery, &c. The subscribers are to appoint the first directors. Reg. office: 25, Mount Stuart-square, Cardiff.

B. YOUNG & COMPANY (BIRMINGHAM), LTD. (167,254)—Private company. Reg. May 8, capital £3,000 in £1 shares, to carry on the business of electrical and mechanical engineers, &c. B. Young is the first director. Reg. office: 100, Leek-street, Birmingham.

Prices of Metals, Chemicals, &c.

Tuesday, June 22.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£101 0 0	—	£4 0 0
Electro Wirebars...	,,	£105 0 0	—	£3 0 0
H.C. wire basis......	per lb.	1s. 2$\frac{11}{16}$d.	—	$\frac{3}{8}$d.
Sheet	,,	1s. 5$\frac{3}{8}$d.	$\frac{1}{8}$d.	—
Phosphor-bronze Wire—				
Phosphor-bronze wire, basis	,,	1s. 7$\frac{3}{4}$d.	—	$\frac{5}{16}$d.
Brass 60/40—				
Rod, basis	,,	0s. 10$\frac{1}{2}$d.	—	$\frac{1}{4}$d.
Sheet, basis	,,	1s. 3$\frac{1}{2}$d.	—	$\frac{1}{4}$d.
Wire, basis	,,	1s. 3$\frac{1}{2}$d.	—	$\frac{1}{4}$d.
Iron—				
Cleveland Warrants	per ton	£11 17 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£51 0 0	—	—
Lead Pig—				
English	,,	£36 0 0	—	£2 10 0
Foreign or colonial	,,	32 15 0	—	£2 15 0
Tin—Ingot	,,	256 10 0	£10 5 0	—
Wire, basis	per lb.	0 3 4	1d.	—

Salammoniac.—Per cwt. 105s.–100s.

Sulphur (Flowers).—Per ton £19.

,, (Roll Brimstone).—Per ton £19.

Sulphuric Acid (Pyrites, 168°).—Per ton. £8 8s. 9d.

Copper Sulphate.—Per ton £44

Boric Acid (Crystals)—Per ton £74.

Carbon Bisulphide.—Per ton £60

Sodium Bichromate.—Per lb 1s. 11d.

Sodium Chlorate—Per lb 5½d

Rubber.—Para fine, 2s. 0¾d.: plantation 1st. latex, 2s. 0½d. per lb.

Shellac.—T.N. Orange, 630s.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

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Forty Years Ago.

(The Electrician, June 26, 1880.)

The Volta Prize.—This prize, instituted in 1852 for the purpose of rewarding the most important applications of the voltaic battery, has this year been awarded by a committee under the presidency of M. Dumas to Alexander Graham Bell for his invention of an articulating magneto-electric telephone. The prize in question consists of the sum of 50,000 fr. A second prize of 20,000 has been awarded to M Gramme for his magneto-electric machine. The Volta prize was awarded for the first time to M. Ruhmkorff, in 1864, for various apparatus of great service in industrial applications.

Edison's Magnetic Ore Separator.—At Washington, on June 1, Thomas A. Edison, of Merlo Park, N.J., was granted a patent for a magnetic ore separator, which allows magnetic and non-magnetic substances to fall together, and then, by magnetic attraction, alters or changes the trajectory of the falling magnetic substance without stopping its fall. From a diagram in the "Scientific American" we gather some idea of the extreme simplicity of this machine, about the utility of which experience will have to decide. Take the top of a turnip-cutter, make the lower opening small, and place upon an open frame. Upon a cross-piece joining two sides of the frame fix an electromagnet, the arms of which reach near to the vertical line below the hopper opening. The magnetic attraction changes the trajectory of the falling magnetic sand without stopping its fall, so that while the silicious sand, gold and other non-magnetic substances fall straight down into one compartment of the receiving hopper, the trajectory of the magnetic sand is changed, so that it falls into another compartment of the receiving hopper. By this means the separation of the black sand is rapidly and completely effected with the expenditure of very little labour.

French Physical Society.—At the meeting of May 21, M. Bontof described, on behalf of M. Righi, an experiment exhibiting "residual magnetism" of polarity opposite to that which prevailed during temporary magnetisation. The phenomenon in this case was shown in a steel bar 5 centimetres in length by 3 in. diameter, magnetised within a coil 5 centimetres in diameter by means of the current from three Bunsen cells. M. Mascart described various arrangements employed for recording the indications of Thomson's electrometer. When the deflections are not proportionate to the differences of potential, the recorded indications may be made so by mounting upon a wheel, constructed with a spiral groove, the thread attached to the recording pencil. M. Pellatt announced that, in his experiments on contact electricity, an electromotive force very high as compared with the thermo-electric effect was obtained by employing two plates of the same metal at different temperatures. M. Hospitalier compared the different modes of mounting employed in exciting the inductor of machines for the electric light. By far the most advantageous is that of Wheatstone, in which the inductor forms a derivation in the circuit. M. Siemens has made some conclusive experiments on this subject. M. Bertin expounded at considerable length the theory of the so-called magic mirrors of Japan.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics": Dinner to the Pioneers of Flight; and Naval Architecture in Aeronautics, by Commander Hunsaker.

"The Cabinet Maker":—(Merchant Shippers' Issue)—"Furniture for Small Houses"; "Openings for Business Abroad"; "Decoration and Furnishing of an Inexpensive Nursery"; "Upholstering Methods and Materials."

"The Chemical Age":—"Refractory Materials for Chemical Purposes": first of a series of articles by A. B. Searle.

"The Fruit Grower":—"Railway Rates Inquiry"; "Unity in the Retail Trade"; and "Climbing Roses."

"The Gas World":—British Society of Gas Industries on "Labour Problem"; Annual Meeting, Society of French Gas Engineers; and Health Ministry's Report on Heating in Housing Schemes.

"The Hardware Trade Journal":—Articles of interest to the merchant shipper and exporter; "Sheffield as the World's Premier Steel Producer"; and "Labour Saving in the Foundry," by Joseph Horner.

"Ways and Means":—"The Go-Slow Life," by The Editor; "Stabilising the Price Level," by Prof. Irving Fisher; and "Gladstonian Finance," by Samuel Cleave.

Arrangements for the Week.

FRIDAY, June 25th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read: "The Origin of the Elements," by Dr. J. H. Vincent, M.A.; "The Construction of Thermo-Couples by Electro-Deposition," by Mr. W. H. Wilson and Miss T. D. Epps; "On the Use of Vacuum Arcs for Interferometry," by Mr. J. Guild; and "The Maintenance of a Vibrating System by Means of a Triode Valve," by Mr. S. Butterworth, M.Sc.

WEDNESDAY, June 30th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Paper on "Electric Railway Contact Systems," by Sir Philip Dawson.

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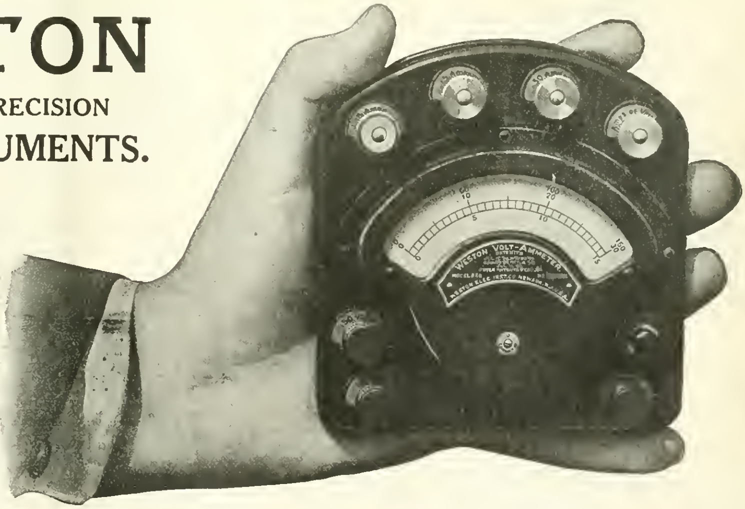

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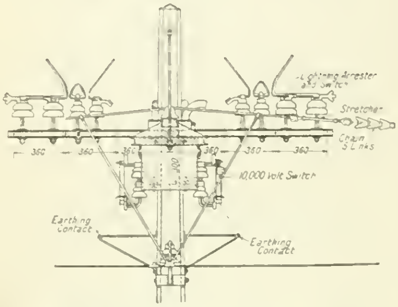

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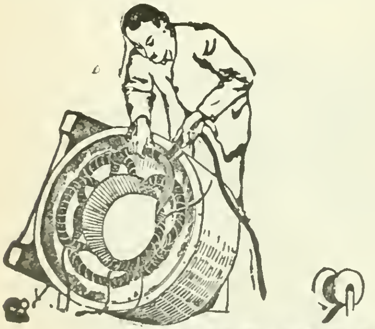

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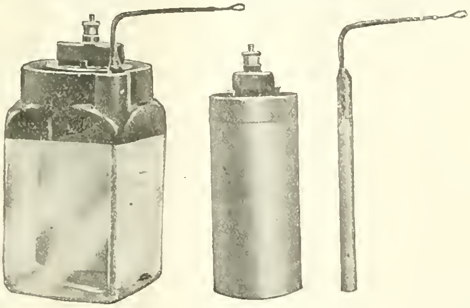

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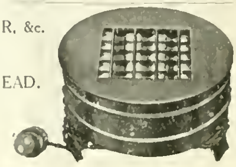

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